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April, 1960

The Mining Magazine

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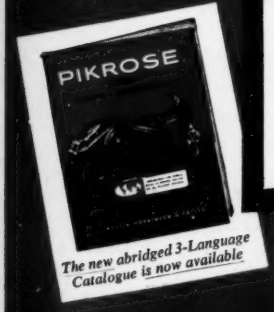

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CONTENTS

EDITORIAL

IT is announced that oil from the Miri field, which has been Sarawak's leading mineral export for 40 years, has now yielded first place to bauxite. Miri oil production in 1959 totalled 395,000 barrels, valued at $2,882,000 (£336,233), but bauxite exports from west Sarawak amounted to 203,000 tons worth $3,843,000 (£448,350). This was more than double the weight exported in 1958. Bauxite mining at Sematan began in 1958 and the deposit being worked is at Munggu Belian, in undulating country about half a mile from Sematan; it is estimated that it will yield over 2,600,000 tons of washed bauxite. The ore occurs in a bed about 10 ft. thick, under a thin cover of soil and is worked by excavators, cleaned at the Sematan washing plant, and stockpiled for loading into steel lighters which deliver the bauxite to ocean freighters. A new washing plant completed last year gives, with the old plant, a maximum potential output of 1,500 tons each 24 hours. The wharf is being extended so that round-the-clock loading can take place this year. During the wet season (November–March) the mine is working 16 hours a day and it is hoped that a stockpile of 100,000 tons will be ready when shipping begins.

Minerals for Mankind

It was in the autumn of 1952 that a Symposium arranged by the Institution of Mining and Metallurgy was held in London to review " Recent Developments in Mineral Dressing." That meeting proved to be the forerunner of a series, which arose out of the rapidly growing demand for mineral raw materials. There followed, in consequence, a meeting in Paris, in the following year, then a gathering in the Harz mining area, at Goslar, in 1955, to be followed two years later by the International Congress in Stockholm in 1957. At that gathering it was arranged that the next international meeting should be in London this year and this meeting—an International Mineral Processing Congress—is in progress as we go to press. The Institution, as is well known, has been privileged over a number of years to precede such international gatherings by the promotion of an inaugural lecture financed out of the fund created out of the beneficence of the late Sir Julius Wernher and his family. In the event we have had this year the fifth of these lectures, this time as an introduction to the current Congress. The happy choice of lecturer for the occasion was Dr. I. W. Wark, Chief of the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Melbourne. At the inauguration of the Congress Dr. Wark delivered his lecture on the " Exploitation of Minerals for Mankind " and the tenor of his remarks is briefly surveyed in the following account.

Dr. Wark was concerned that the life-blood of future production in the mineral industry—that is, metallurgical research—should lag as compared with the researches in progress in other branches of industry. He thought it possible that outlook had become too parochial and advocated a greater spirit of adventure in the approach to mineral processing. He suggested that of the two methods of approach to mineral research—the empirical and the fundamental—the latter, with time and adequate financial backing, was the surer. It had, he thought, the additional attraction that even if the practical problem proved to be insoluble they would certainly add to the world's store of scientific knowledge. In the fundamental approach, as he saw it, they had first to identify all the relevant variables, determine quantitatively how each influenced the process (and perhaps each other), and finally to select the best combination for the particular purpose. In effect, he said, they worked on model systems and gradually built up toward the complex systems of practice. His colleagues and himself had used that method in flotation studies in Australia.

After a review of fundamental work in progress in Australia and an assessment of the positive results forthcoming Dr. Wark suggested that it was imperative that in exploiting minerals for mankind that mankind was not exploited for minerals. Within any given country the main factors which differentiated the mining industries from the manufacturing were, he said, isolation and, as a consequence, poorer educational facilities, some health hazards, non-permanence of home and livelihood, and possibly severe weather conditions. Often added to those in the bad old days were devastation of an originally pleasing countryside, with trees removed for firewood or killed by sulphurous

fumes. Not all of those disabilities could be removed, but most Australian mine managements were now doing as much as possible to alleviate what remained. Broken Hill, fast becoming a treeless, dusty town, had been beautified and improved; it was no longer a hardship to live there. Responsible prospecting companies, he suggested, recognized that it was good policy to start correctly rather than to try to make amends later. Indeed, he pleaded that in exploiting minerals there should be no desecration of the landscape.

Australia, Dr. Wark said, owed much to its mineral industry. A land being newly opened up tended to follow established procedures and it was only natural that an overseas company would prefer to avoid the effort of modifying standard processes to cope with local raw materials. He thought he was not alone, however, in concluding that if a country is to exploit its minerals satisfactorily it must establish facilities for research and development. This was why they in Australia had set up establishments like the C.S.I.R.O. Some of the overseas companies operating in Australia had shown nothing but greed, cold efficiency, and a cynical disregard for local opinion and aspirations in their outlook. Fortunately, that was less true of mining than of financial and manufacturing companies, but in a world striving for security the mineral industry could have a magnificent destiny to maintain a spirit of adventure in at least one great branch of technology and commerce. He hoped that spirit would be as apparent in the processing of minerals as it was in prospecting and exploring for new mineral deposits.

Tinstone and Columbite-Tantalite Deposits of Kivu

In an interesting memoir published in Belgium Dr. Nicolas de Kun [1] has given a detailed account of the tin, tantalum, and niobium deposits of North Lugulu, Kivu, Belgian Congo. This is the world's principle source of tantalum and the third most productive source of niobium, besides ranking as the Congo's third most important source of tin. The primary deposits occur as veins, greisens, and pegmatites, all close to the contact of granite with pre-Cambrian schists, but the principal production is derived from a placer belt three miles wide and 100 miles long, marginal to the granites. A marked zoning of the tin : niobium ratios is evident across the granite contact, with high niobium in the intrusive rock and high tin in the metamorphic aureole. Pegmatites carry both tin and niobium, usually with the core or inner zone significantly richer in columbite.

Most of the cassiterites bear appreciable traces of Fe, Nb, W, Ti, niobium being present (probably as sub-microscopic columbite) in the darker varieties. Magnetic cassiterite contains 0·2–0·3% niobium and is more frequent in deposits where the concentrates carry less free columbite. The average Ta_2O_5 content of the columbite-tantalite is 28% and the mineral commonly contains sufficient uranium (0·3–0·4%) to give it a perceptible radioactivity. Unlike the Nigerian mineralization yttrium earths predominate over cerium and while xenotime is often abundant (forming 20% of some concentrates) monazite is rare. Apparently thorite, characteristically present in many Nigerian placers, is entirely absent from these Congo deposits.

[1] DE KUN, NICOLAS. Les gisements de cassiterite et de columbo-tantalite du Nord Lugulu, Kivu, Congo Belge. *Mem. Soc. Géol. Belg.*, vol. 82, pp. 81–196, 1960.

Northern Rhodesia

It was announced last month that the copper-mining companies operating in Northern Rhodesia are to make available the sum of £1,300,000 towards the cost of additional facilities for African education. By arrangement with the Northern Rhodesia Government the Rhodesian Selection Trust group and those concerns administered by the Anglo American Corporation are to devote this sum to the capital cost of providing six years of primary education for those African children in the Copperbelt reaching the age of eight for whom no places would otherwise be available. In addition, the plan will also provide for further primary and secondary schooling for a proportion of the children and for the training of teachers. The monies are to be made available by the two groups over several years; they will be half in the form of low-interest loans and half in the form of donations and will be additional to any expenditure on education in the Copperbelt already projected by the Northern Rhodesia Government. It is expected that a further statement will be available next month.

Last year, it has recently been stated, copper production in Northern Rhodesia was a record by value and amount, a provisional summary of production from the Mines Department indicating that the value of all minerals produced in the Colony was £125,531,579. Since last July copper values have been based on free-on-rail at mine rates and to make a comparison with the previous record total (£130,339,806 in 1956, when copper prices were considerably higher) it is necessary to include amounts averaging about £1,000,000 a month as an adjustment to the mean London Metal Exchange prices on which the 1956 figures were calculated. On this basis the 1959 production aggregated over £131,500,000, the 1958 figure being £77,225,327.

The new record figures for Northern Rhodesian copper reflected a steep increase in the quantity of the metal marketed from mines of the Anglo American and Rhodesian Selection Trust groups, as well as of the use of additional refinery capacity. The total of 364,595 tons of electrolytic copper, the value of which (£82,089,094) was about two-thirds of the figure for all minerals, was well above the previous record of 246,680 tons (£54,416,299) for 1957. Although the companies concentrated on the quality product, output of blister copper was maintained at 165,543 tons (£34,945,876). Quantitatively, Northern Rhodesia's 1959 production of gold, silver, cobalt, manganese, selenium, and limestone was also the highest recorded. Values of the gold, silver, cobalt, manganese, and limestone also set new records.

Mining at Cardiff

The Mining Department of the University College of South Wales and Monmouthshire was founded in 1891 to provide facilities in Wales for the training of mining engineers to university standards concurrently with allied sciences, economics, and industrial relations. This work in the South Wales coalfield is considered of vital importance to its future, since the recent recession in the industry which has led to the "Revised Plan for Coal" put forward by the National Coal Board in October, 1959, will have practically no effect on the planned future expansion of the field. The district is situated in a highly industrialized area and conveniently placed and equipped for the export of coal. The coal reserves are very large and of exceptionally high quality, particularly in the coking coal and anthracite districts. The field is also of paramount importance in the supply of smokeless fuels.

It has been announced that the National Coal Board intends to spend £84,000,000 during the next five years in South Wales and the target output for 1965 is 24,000,000 tons to 26,000,000 tons, as compared with an actual output of 21,200,000 tons in 1959. The manpower to be employed in 1965 is estimated at 90,000 to 94,000, against 90,000 in 1959. In order to achieve the increase in productivity that these figures envisage many of the producing collieries in 1965 will be either new or reconstructed pits. In addition the coalfield still has a backlog in places of bad industrial relations and technical stagnation which it is the function of education to redress.

To this end the Mining Department intends and is equipped to play its full part. The construction of its new block was started in 1957 and completed at the end of last year. The building was officially opened by H.R.H. The Duke of Edinburgh, Chancellor of the University of Wales, on March 11. The first half of the new block was occupied at the end of 1955. With the opening of the final section the Mining Department now has a main lecture theatre and lecture rooms, as well as extensive research and demonstration laboratories. The basement rooms comprise an extension to the workshop, a heavy research laboratory, a flotation and filtration laboratory for mineral preparation, an extension to the general mining laboratory, and a store room.

Since its inception the Department has taken an important part in the investigation of the technical and safety problems of the coalfield. From the days of its first professor, Sir William Galloway, it has always been particularly interested in and taken a leading part in the investigation of the problems of coal dust in mines, in recent years in conjunction with the Monmouthshire and South Wales Coal Owners Association, the Medical Research Council, and the National Coal Board. In the new building facilities for research into these and many other problems have been greatly enhanced and an enthusiastic research team has been gathered together which is carrying out work on a number of problems currently engaging the coalfield. This co-operation between the Department and the industry is already paying dividends.

MONTHLY REVIEW

Introduction.—The implications of the Budget statement and the influence of the troubles reported from South Africa have not seriously affected commodity prices and business confidence is well sustained. While the provisions of the Finance Bill have met with mixed reception it has certainly helped sentiment abroad towards British currency.

Transvaal.—The output of the gold mines of the Witwatersrand and Orange Free State for February totalled 1,675,248 oz., making with 38,859 oz. from outside districts, a total of 1,714,107 oz. for the month. The number of natives at work in the gold mines at the end of February was 385,027, as compared with 372,254 at the close of the previous month.

Last month HARTEBEESTFONTEIN GOLD MINING announced further results obtained in deflections of bore-hole HB 24. In the first the Vaal Reef was intersected at a depth of 6,731 ft., assaying 5·74 dwt./ton over a corrected width of 41·6 in. In the second the same Reef was cut at 6,730 ft., assaying 6·26 dwt./ton over a corrected width of 43·9 in. Core recovery was complete in both deflections. In the original hole the Reef was intersected with incomplete core recovery at 6,734 ft., assaying 8·07 dwt./ton over a corrected width of 39·2 in.

Shareholders of WEST DRIEFONTEIN GOLD MINING were recently informed of the directors' intention to recommend a capitalization issue of shares out of share premium account on the basis of one such share for every one existing.

On March 14 the directors of WESTERN DEEP LEVELS announced that the Ventersdorp Contact Reef had been intersected in the No. 2 main vertical shaft at a depth of 5,599 ft. below the shaft collar. The reef was exposed over a distance of 80 ft. round the perimeter of the shaft, dipping 28° in a south-easterly direction. In the remaining 10 ft. it was incompletely exposed due to faulting. Sampling at 5-ft. intervals of the reef fully exposed gave an average value of 7·59 dwt. per ton over an average channel width of 41·5 in., equivalent to 315 in.-dwt. At the extraordinary meeting held on March 31 a special resolution was passed increasing the capital of the company from £5,601,000 divided into 5,600,000 "A" shares of £1 each and 1,000 "B" shares of £1 each to £18,600,000 divided into 5,600,000 "A" shares of £1 each and 13,000,000 "B" shares of £1 each by the creation of 12,999,000 "B" shares of £1 each, as well as an ordinary resolution authorizing the directors to issue, subject to the terms of the flotation agreement, the 13,000,000 "B" shares of £1 each at their discretion. An offer of 2,800,000 "B" shares is to be made this month at a price of 40s. per share (South African currency) payable in cash.

In a recent circular shareholders of NIGEL GOLD MINING were informed that the directors had received from the UNITED FINANCE CORPORATION OF SOUTH AFRICA an offer to purchase all the issued shares of the company from shareholders at 2s. per share. The board is considering this offer, it is stated, and is shortly to issue a circular giving further details of the offer.

With the recent dividend notice shareholders of RUSTENBURG PLATINUM MINES were informed that, in order to build up stocks of platinum to suitable levels, mine production continues at a rate in excess of that required to meet the estimated level of sales for the current financial year. Operations at the Rustenburg and Union sections have been and will continue to be adjusted as necessary from time to time in the light of circumstances and in such a manner as to achieve maximum overall efficiency from the various mining sections and reduction plants available for operation. Present estimates are that the volume of sales during the current financial year is likely to exceed to some extent that of the previous year.

The output of many mines on the Rand and the Orange Free State were affected by the power cuts imposed by the Electricity Supply Commission in the middle of March.

The report of RANDFONTEIN ESTATES GOLD MINING for 1959 shows a profit of £1,440,635 and a total of £1,853,177 available, of which dividends equal to 4s. a share required £812,711. In the year 3,011,480 tons of ore crushed yielded 170,847 oz. of gold and 1,850,129 lb. of uranium oxide.

The operations of GOVERNMENT GOLD MINING AREAS in 1959 resulted in a profit of £330,446. The accounts show £814,415 available for appropriation, of which a capital repayment equal to 1s. per share required £350,000. In the year 635,000 tons of ore was milled and 114,731 oz. of gold produced. The pyrite plant recovered 189,052 tons of concentrates.

EAST CHAMP D'OR reports a profit of

£67,068 for 1959, the accounts showing £95,264 available, of which dividends totalling 6d. a share require £51,975. In the uranium division of the mill 144,000 tons of ore yielded 114,024 lb. of uranium oxide and 3,629 oz. of gold, while the gold plant recovered 3,179 oz. from 16,400 tons.

The accounts of BRAKPAN MINES for 1959 show a surplus of £201,199 and a total of £541,425 for appropriation, of which a dividend equal to 4½d. a share required £86,250. The mill crushed 1,672,000 tons of ore in 1959 and recovered 202,678 oz. of gold. Ore reserves are given as 1,593,000 tons averaging 4·79 dwt. in value over 53·59 in.

The report of SPRINGS MINES for 1959 shows a profit of £205,055 and a total of £502,245 available for appropriation, of which £232,768 is carried forward. In the year 170,961 oz. of gold was recovered from 1,247,000 tons of ore milled. The ore reserves at December 31 last were estimated to be 1,171,000 tons averaging 4·41 dwt. in value over 42·25 in.

Orange Free State.—The accounts of FREDDIES CONSOLIDATED MINES for 1959 show a working loss of £493,429 offset by £426,945, the net revenue from the production of uranium oxide. In the year 169,952 oz. of gold was recovered from 708,000 tons of ore milled, while the company's share of uranium oxide under the joint production scheme was 224,887 lb. Ore reserves equal to 1,005,000 tons averaged 5·5 dwt. in gold and 0·33 lb. in uranium oxide.

Diamonds.—Earlier this month DE BEERS CONSOLIDATED MINES announced that in the March quarter the sales of diamonds effected through the Central Selling Organization totalled £20,396,151, of which £14,026,975 is attributable to gem stones.

Southern Rhodesia.—A profit of £151,236 for the year to September 30 last is reported by FALCON MINES, the accounts showing £164,808 available, of which dividends totalling 17½% require £79,433. At the Dalny mine 241,000 tons of ore was milled and 45,184 oz. of gold recovered, while a further 4,801 oz. came from clean-up and reclamation work at the Sunace and Bay Horse properties. Ore reserves at Dalny are given as 672,000 tons averaging 4·9 dwt. over 107 in.

Last month the WANKIE COLLIERY COMPANY announced that "after exhaustive investigations spread over more than 2½ years" it had come to the conclusion that the establishment of an oil-from-coal industry in the Federation of Rhodesia and Nyasaland was not, at present, economically practicable. Two schemes were considered, the first based on the Lubimbi coalfield, which had the special merit of containing large reserves of medium-to-low grade coal which is eminently suitable for gas synthesis. This scheme, however, was rejected as financially and commercially unsound because it would have entailed the establishment of a new coal mine and a costly construction programme which would have to include housing, water supplies, and a power generation plant. Attention was, therefore, given to the alternative of drawing supplies of coal from Wankie and siting the plant at either Livingstone or Bulawayo, where the necessary amenities are available. Investigations on this scheme were also discouraging and it is concluded that, although many advantages could flow from the establishment of such an industry in the Federation, "it is clear that it cannot be operated economically, at present, by private enterprise alone."

Northern Rhodesia.—With the final dividend notice shareholders of RHODESIA BROKEN HILL DEVELOPMENT have been informed that the operating profit for 1959 was £885,918, against £590,739 in the previous year.

At the customary informal meeting of shareholders in companies of the RHODESIAN SELECTION TRUST group, held in London on April 7 the chairman, Sir Ronald Prain, referred to the steps being taken to increase mine output. Once the work is completed production capacity at the three mines will have been raised to about 260,000 tons annually. He welcomed the fact that the Kariba dam, to be opened officially by H.M. Queen Elizabeth The Queen Mother next month, was already helping by the production of power. Speaking of prospecting Sir Ronald said that this continues at a high tempo, the areas now being covered amounting to about 90,000 square miles, of which more than 40,000 are in Bechuanaland. A company has been formed to carry out this concession and is called BAMANGWATO CONCESSIONS, LTD., registered in Bechuanaland.

Ghana.—At the recent annual meeting of the ASHANTI GOLDFIELDS CORPORATION shareholders were informed that the capacity of the treatment plant was now 35,000 tons monthly, while gold recovery had been raised to 93%. In the current year it is planned to increase the milled tonnage from

406,000 to 425,000, while the development programme calls for 54,000 ft. at an estimated cost of £545,000. Priority is to be given to developing the downward extension of the southern ore-shoots of the Main Reef on 35, 38, and 41 levels. The South ore-bodies are also to be explored on 26, 29, and 32 levels and on the Cote d'Or Reef the downward extension of the 42S to 51S block on 20 level is to be tested on 21 and 23 levels. At Ayeinm further work will be done on the No. 3 lode and the extension of the 161S to 177S block on 10 level will be tested on 9, 11, and 12 levels. Between 12 and 16 levels development of the East Reef and the footwall spur will continue. At Ayeinm shaft preparatory work will continue to enable deepening from 12 level to 26 to start next October.

Nigeria.—It is announced that a commission of inquiry has been set up by the Nigerian Government to inquire into the problems of the Nigerian coal industry. POWELL DUFFRYN TECHNICAL SERVICES, LTD., it is stated, have agreed to second their chief coal mining engineer, Mr. J. T. B. Welbourn, to serve as the technical member on the Commission. The inquiry opened at Enugu on March 21, 1960.

The report of the NIGERIAN COAL CORPORATION for the year ended March 31, 1959, shows that a total of 905,397 tons of coal was produced, of which 20,046 tons came from the new Ekulu mine. Operations resulted in a profit of £155,073, which reduced accumulated losses to £65,852.

Australia.—At the annual meeting of MARY KATHLEEN URANIUM last month it was stated that exploration and development had indicated that the uranium deposit was likely to have a much longer life than had been originally supposed. Last month the company announced that it had offered the Australian Workers Union a production bonus scheme to operate until the company has delivered the total tonnage of uranium oxide which it has contracted to supply to the United Kingdom Atomic Energy Authority. The principle behind the scheme is to pay to employees a bonus with their regular rates of pay that is related to the dividends paid to the shareholders. The scheme has been accepted on behalf of the Union.

Malaya.—The directors of Temoh Tin Dredging, it is announced, have decided to recommend a capital repayment of 2s. 6d. per stock unit. An extraordinary general meeting to approve the proposal is to be convened in the near future.

Shareholders of PUSING RUBBER AND TIN have been informed that the balance of the purchase money on the sale of the company's estate and mining leases has been received. A further communication is to be sent to shareholders at an early date as to the disposal of the net assets of the company.

Burma.—With the recent dividend notice shareholders of BURMA MINES were informed that the accounts of the company for 1959 show a profit of £88,461, before taxation, as compared with £56,381 for the previous year. The report notes that production of saleable products during 1958–9 attained the highest level in the history of the joint venture, although the mine has still some way to go to bring ore extraction up to the capacity that can now be dealt with by the improved mill. Every effort is being made to improve mine output.

Mexico.—The operations of SAN FRANCISCO MINES OF MEXICO for the year ended September 30 last resulted in a profit of £133,514, a credit balance of £379,934 being carried forward. A record tonnage of 808,400 metric tons of ore, the report states, was milled during the year, the grade being approximately the same as that milled in the previous year. The increased tonnage milled was obtained with a reduced underground labour force, so that, despite a 12% increase of wages granted in October, 1958, total operating costs of £2,532,342 were held at about the same level as in the previous year. Development work at the Frisco and Clarines mines totalled 9,692·7 metres; 7,255·8 metres were on veins, of which 42·86% was payable. The fully and partly blocked ore reserves were increased by 90,150 metric tons to 5,638,230 metric tons of slightly higher average grade.

Brazil.—At an extraordinary meeting of the ST. JOHN D'EL REY MINING COMPANY held on March 24, resolutions were passed: Authorizing the increase of the capital to £1,600,000; authorizing the transfer of the seat of management and control of the company from the United Kingdom; authorizing the introduction of a Bill into Parliament for the transfer of the registered office to Brazil, and amending the borrowing powers of the directors in line with modern practice.

Canada.—The report of the RIO TINTO MINING CO. OF CANADA for 1959 shows a consolidated net profit of $2,756,812 against $488,497 in 1958. The sum of $2,028,067

has been written off intangible assets, $102,851 off investments in a subsidiary not consolidated, and $625,894 has been provided for investment depletion, leaving the carry-forward unchanged at $393,335. It is stated that the amalgamation of the four operating companies in the Elliott Lake area, which ensures continued uranium operations until the end of 1966, has partly offset the effects of the Government's announcement of November, 1959. Steps to diversify operations have been intensified, it is stated, and, when coupled with the programme of research and exploration they give sound grounds for anticipating a healthy and expanding role for the company. A syndicate consisting of the company and certain affiliated companies was organized during the year in order to finance and share in new projects, particularly those involving airborne work or other exploration in virgin areas. Most of the new projects undertaken in the latter part of 1959 were by this syndicate of affiliated companies.

Last month the BRUNSWICK MINING AND SMELTING CORPORATION announced that it had agreed "in principle" with SOGEMINES to begin production at the lead-zinc property in New Brunswick. The initial rate of production would be 2,000 tons daily. Negotiations are reported to provide for a 15-year contract for the sale of concentrates to a group of Belgian base-metal smelters.

United Kingdom.—The operations of SOUTH CROFTY in 1959 resulted in a profit of £31,478. No dividend is to be declared for the year.

HALKYN DISTRICT UNITED MINES reports a loss of £4,615 for 1959. An available balance of £33,258 is carried forward.

British South Africa Company.—At the recent annual meeting of the British South Africa Company last month the chairman stated that at March 9 the total book value of the Group's investments amounted to £43,723,000, made up of quoted investments £28,296,069 and unquoted investments £15,426,931. The market value at that date of the quoted investments was estimated to be £40,065,432, showing an appreciation over book cost of £11,769,363. In addition there was an estimated undisclosed appreciation on certain of the unquoted holdings of not less than £5,000,000.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated.)

†**African and European Investment Co.**—3s. 6d., payable May 12.
†**Anglo American Corporation of South Africa.**—7s., payable May 12.
Apex Mines.—Pref. 6·6d., payable May 11.
***Ayer Hitam Tin Dredging.**—9d., payable May 17.
***Beralt Tin and Wolfram.**—1s., payable May 10.
†**Blinkpoort Gold Syndicate.**—2s., payable May 25.
†**Burma Mines.**—1¼d., free of tax, payable May 12.
†**Consolidated Tin Smelters.**—3½%, payable May 12.
***Coronation Syndicate.**—3d., payable May 31.
†**De Beers Consolidated Mines.**—7s. 6d., payable May 17.
†**Falcon Mines.**—6d., payable May 9.
***Harmony Gold Mining.**—1s. 3d., payable May 25.
***Lake View and Star.**—1s., payable May 27.
†**London and Rhodesian Mining and Land.**—1½d., payable May 19.
†**Lydenburg Platinums.**—5¼d., payable May 12.
***Malayan Tin Dredging.**—4½d., payable May 24.
***Mount Lyell Mining and Railway.**—1½d. Aust., payable May 5.
North Charterland Exploration Co. (1937).—2d., payable June 20.
***Potgietersrust Platinum.**—5d., payable May 12.
†**Rhodesia Broken Hill Development.**—9·6d., payable May 12.
***Rhodesian Anglo American.**—3s. 2·4d., payable May 12.
***Rhokana Corporation.**—2s. 4·8d., payable May 12.
†**Rio Tinto Co.**—2s., payable June 3.
***St. Helena Gold Mines.**—2s. 3d., payable May 25.
***Southern Malayan Tin Dredging.**—4½d., payable May 19.
***Sungei Besi Mines.**—1⅜d., payable May 12.
***Tronoh Mines.**—7½d., payable May 10.
***Wankie Colliery Co.**—6d., payable May 27.
†**Union Corporation.**—2s. 9d.
***Union Platinum Mining.**—8d., payable Apr. 12.
***Waterval (Rustenburg) Platinum.**—8½d., payable Apr. 12.

METAL PRICES

April 7.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	30	5	0
Silver		6	7
Gold	12	10	0
Wolfram U.K.)		—	
(World)	7	9	0

Tin, Copper, Lead, Zinc } See Table, p. 248.

South African Mining in 1959

L. A. Waspe

Events in another year of expansion are critically reviewed

Gold and Uranium

In 1959 the outstanding feature of the South African mining industry was gold production, which reached new record levels in all aspects. Continued expansion by the new mines more than offset contraction at the other extreme of the scale—that is the older gold producers of the Witwatersrand, many of which are now nearing their end. In general, the new mines of the Far West Rand, the Klerksdorp area, and the Free State goldfield reached the stage at which ore reserves had been built up to tonnages permitting the maintenance or expansion of milling rates, while development programmes could be extended into new sections and additional shafts sunk to facilitate opening up new zones (thereby providing for a further expansion of milling rates to projected ultimates) and to raise ventilation capacities, required not only for current operations (in what are mainly higher temperature zones) but also for the extension of workings in some cases to greater depth. In instances, the increases in ventilation capacities were supplemented by the installation of new or additional refrigeration units. Particularly in the Free State field, one of the objectives of the intensified attention to ventilation was the continued and sometimes greater disclosures of methane gas and, it would appear, sulphuretted hydrogen in isolated cases.

In the case of many of the new gold mines, there appeared to be an upward revision of the projected ultimate milling rates, probably related to the economic balance of issued capitals, actual or prospective tax/lease liabilities, capital expenditure involved in the programmes of expansion, disposable or distributable income, and, where relevant, probably also to expectations of reduced income from uranium oxide in the post-contract period.

In 1959 the aggregate uranium contractual sales quota (to the Combined Development Agency of the United States and United Kingdom) was maintained at 6,200 tons a year, as compared with productive capacity of 7,200 tons, which quota will be the annual rate, apart from extraneous sales, to the end of 1964, when individual contracts begin to expire. Providing the demand is there most of the uranium producers are expected to be competitive in the post-contract period after 1964–66. An intensive programme of research has been initiated to reduce costs of uranium extraction, to improve relevant processes, to effect greater refinement of the finished product, and to study the possibility of extending the final stage to the production of uranium metal.

Electric power supplies in 1959 were adequate for all requirements. There were no reports of shortages or shortfalls in the availability of stores and equipment. Population growth, a reduced rate of industrial expansion and activity promoted the recruiting of a record native labour complement, to which in the Union itself the control of the native influx into urban areas materially contributed. The foregoing economic factors (and relatively reduced imports) enhanced the improved carrying capacity of the railways. Conditions generally therefore were favourable for expansion on the part of the new gold mines and for a higher rate of production by the mid-term producers.

The average gold grade to mill improved further in 1959, partly because of more selective mining to counter higher pay-limits, partly because of the inherently higher grades of the new mines, and, in many cases, partly because of intensified beneficiation through increased surface waste-sorting rates. One effect of such sorting was/is to raise effective plant capacities in both the gold and uranium sections. Another was/is to improve process efficiencies and general results in the latter. Interest attaches to the effect on the mill grade of expansion and extension of opera-

tions. While in some cases the higher milling rates projected will facilitate mining and treating lower overall gold grades, more representative of the respective mines than those now the rule, in others bore-hole indications were such as to induce the expectation of a further advance in the mill grade (particularly Free State Geduld, Western Holdings, Harmony, Saint Helena, possibly Vaal Reefs, and in the more distant future possibly in the case of Hartebeestfontein).

Economy measures have been applied wherever possible to curb the upward pressure on costs. General factors making for higher costs, which have raised the average pay-limit above the 1949 pre-devaluation level, include higher charges for stores and supplies, rail, and power services, and higher wages/salaries. Control measures embrace the issuing of stores, better personnel training, more efficient application of labour, planned mechanization, and improvements in operational methods. Excluding mines primarily uranium producers (where gold is the by-product) average costs per ton milled and per ounce produced were reduced in 1959. In individual cases, over 1959, costs per ton were reduced in 15, rose in 33 instances, and were unchanged in one instance ; per ounce, they were reduced in 21, rose in 28 instances, the higher grade treated and yield contributing thereto. Conditions peculiar to individual mines—such as development charges set against working costs ; pumping and ventilation charges, waste-sorting costs, and more expensive stoping methods (due to geological features or anomalies)—singly or in combination have been aggravating factors in the cost structure. In some cases deeper operations have contributed to higher costs—E.R.P.M. and City Deep and Crown Mines are pertinent examples. The further scaling down of operations by most of the older mines influenced higher costs.

In 1959 the fiscal concession to gold mining took the form of the additional amortization allowance in respect of capital expenditure incurred in ultra-deep operations being extended from a specific case, Western Deep Levels, to all mines—the upper ultra-deep limit being set at 7,500 ft. Over the next five years or so E.R.P.M. will be completely converted to ultra-deep operations, while in 1959 the City Deep mine was being reorganized for similar operations in a slightly extended lease area, in and for which shaft-sinking and development are being accelerated. Four mines—Western Deep Levels, E.R.P.M., City Deep, and Crown Mines—at present qualify for the amortization allowance mentioned and are classified as ultra-deep units.

Although improved, the white complement of the gold mines still reflected shortfalls, especially in the engineering categories (mechanical and electrical), in the number of recruits for the Miners' Training Schools, and in the number of learner-officials. The long-term outlook remains a matter of concern. A new learner-official scheme for training mechanical and electrical engineers has been introduced by the gold mines. No attempt has been made as a matter of policy to replace Europeans by non-Europeans. Future cases of any alleged such replacement will be discussed with the management by the trade union/s concerned, with the right to refer relevant matters to the Chamber of Mines.

Over the last year or so the organized economic sectors of the country reached common ground and a common view-point on the gold question and have urged the necessity for revaluation of the metal in terms of currencies. Various schemes, promoting private sales of gold by authorized bodies to non-sterling residents, were initiated in 1959 and have become extensive and substantial. The indications are that operations by the older mines are being spun out in the hopes that a higher gold price will eventuate during the remaining years of their predictable economic lifetime. In instances, sections which are presently not economically workable are being maintained in a condition permitting an immediate resumption of working at the appropriate time.

While water requirements have been fully satisfied and are expected to be satisfied for years ahead, the Vaal River Catchment Association was established urgently in 1959 to prevent the misuse of land and water in the catchment area (which is the main source of supply to the gold mines and the uranium plants) and to study and develop means of re-using Vaal River water to the end of conserving supplies for the future. The de-salting plant commissioned in the Free State goldfield to render water pumped from underground suitable for industrial and agricultural uses is functioning satisfactorily. There were further moves by the major mining houses to spread their interest on a wider basis both qualitatively and geographically, especially in Southern Africa,

mainly by mergers and through share exchanges.

Projected milling capacities or capacities already installed include the following: Free State Geduld—125,000/150,000 tons; Welkom — 125,000/150,000; President Brand—150,000/180,000; President Steyn — 125,000/150,000; Western Holdings — 175,000/210,000; Harmony — 200,000/240,000; Winkelhaak — 90,000/110,000; Loraine — 75,000/90,000; Hartebeest - fontein — 130,000/160,000; Virginia — 150,000/180,000; Buffelsfontein—200,000/240,000; West Driefontein — 205,000/245,000 (about 130,000/155,000 for Carbon Leader Reef and 75,000/90,000 for Ventersdorp Contact Reef); Vaal Reefs—150,000/180,000; Marievale — 90,000/110,000; Durban Roodepoort Deep—205,000/245,000 (in one extended centralized plant); Stilfontein—180,000/225,000; Doornfontein—100,000/120,000, all tons per month. Harmony extended its uranium plant capacity to 120,000/144,000 tons a month to provide for a total sales quota of 844,780 lb. U_3O_8 a year and erected a sulphuric acid plant to treat sulphide from its flotation plant.

With the new gold mines having consolidated development and largely appropriating capital expenditure requirements from income, and with the financial and economic background becoming favourable for the exploitation of new projects, prospecting in 1959 was extended appreciably over larger areas. Options over considerable areas were taken up in the Western Transvaal, where the focus of attention was the Ventersdorp-Coligny zone. Areas on the western and eastern rims were also placed under option, respectively north-eastward and north-westwards (extending into the Western Transvaal) from the Free State field. Another sector to receive attention was that northwest of Bloemfontein. Under the stimulus of mining results to the north a two-year drilling programme was initiated in an extensive area to the north of the Vaal River and to the south of the Doornfontein-Blyvooruitzicht-West Driefontein mines. Drilling to test the extension of the ore-bodies from the Doornfontein and Libanon mines became scheduled. Favourable drilling results were disclosed in the zone immediately south of the Vaal Reefs mine, in which zone a mine will probably be established, while east of that zone (in what may be the eastern limb of a syncline) further drilling was initiated—namely, south of the Buffelsfontein mine. Further drilling was also undertaken south of President Steyn and west of Harmony.

In the Kinross area of the Eastern Transvaal, west of Winkelhaak, the Bracken and Leslie mines were established, which, with respective indicated grades of 450 and 350 in.-dwt in relatively shallow formation, are expected to reach production in the 1963–64 period. Another successful drilling programme resulted in the establishment of the Western Areas mine, south of Randfontein, with an indicated grade of about 560 in.-dwt and with a high claim-tonnage. Another mine may be proved in the Kinross area. The Chamber of Mines president recently commented that the South African gold-mining industry had not yet reached its prime, which may suggest further disclosures of new discoveries in due course. East of Klerksdorp Zandpan initiated shaft-sinking; south of the West Wits. line Western Deep Levels has completed the vertical components of one twin-shaft system and is near the completion of counter-parts in the second system.

Research was continued into rockbursts and strata movements and is being advanced further. Other research embraces various aspects of labour performances under mining conditions and reactions thereto; physical characteristics of various ethnic groups; aspects of ventilation; radioactivity in mines, and rendering underground timber fire-resistant.

In many cases (Harmony, Free State Geduld, Doornfontein, Blyvooruitzicht, and West Driefontein appear to be the main examples) extensive footwall development was advanced ahead of and preparatory to cutting stope blocks on reef. This effort was not immediately reflected in the ore-reserve tonnages. Many of the new gold mines installed or converted to automatic or semi-automatic hoisting to increase hoisting capacities.

To conform to the plan-layout of circular shafts and, in the Free State field, to shift the weight away from the shaft collar and cope with surface and subsurface unstable ground, practice in headframe design became more inclined to the A-type at new shafts. Shaft-sinking techniques benefited from mechanical refinements especially in the grab-assembly and sinking-stage arrangements and design, which were reflected in the world sinking records at Vaal Reefs and President Steyn. Further refinements were effected in underground electric loco. design to render it competitive

with diesel locos. and more readily applicable in respect of ease of control and ventilation requirements. High-pressure plastic hosing was evolved for mining duties and was being intensively tested. Bakelized wooden ventilation ducting was introduced in a localized application in place of conventional galvanized ducting as a counter to corrosive underground Free State water. Because of higher aerodynamic efficiencies hollow-rounded-face steel buntons were introduced. Scale-model tests were started on free-hanging rope-guides for shafts, especially to obviate swaying (and collisions) resulting from aerodynamic forces. An automatically adjusting bank platform, maintaining alignment with cage floors was designed. An electronic testing device—utilizing electromagnetic flux—was developed for testing wire ropes used in hauling and hoisting.

A health-trend survey showed a gradual reappearance of enteric fever, despite prophylactic treatment. Respiratory diseases remained the main hazard to health, especially in the Free State mines which have a greater percentage of tropical natives.

Base Minerals

Antimony.—The country's solitary producer of cobbed ore and concentrates at Gravelotte in the Northeastern Transvaal reported better sales, expanded output, extended its claim area, and resumed exploratory development.

Asbestos.—Sales in the early part of 1959 reflected import restrictions and adverse economic conditions in the asbestos export markets. As the year progressed sales improved and production was stepped up. However, it would appear that production was held well below capacity levels to reduce accumulated stocks, especially by the chrysotile producers. Unit prices were on average lower and did not recover commensurately with the hardening of demand. In many cases operations were directed towards improving producing facilities for the next upward phase of the periodic movement. On balance producing capacity was raised and in one area of the Northern Transvaal a number of small producers were merged under the control of a major producer.

Chromite.—Producers had not the easiest of years. With surpluses much in evidence, production was scaled down well below capacity rates or even temporarily suspended. One producer sold a controlling interest to Allied Chemical Corporation of New York, with which it concluded a long-term contract for sales.

Coal.—The 1959 declines were attributed to the working down of stocks held by the major consumers to the mild winter and the more restrained tempo of industrial activity. During the year the rail-carrying capacity improved to the extent of rendering unnecessary the continuation of road transport in the Southern Transvaal area. The native labour complement improved to numbers generally exceeding requirements, but to provide against future possible shortfalls and undue fluctuations in this respect the extension of mechanization was continued. The extension of workings was moderate, a few new pits were opened up, and, in line with the steel-expansion programme, output capacity of coking and blend-coking coal was raised and will probably be expanded further. In some cases ventilation capacities were improved, as were producing facilities. Generally output was below capacity rates and is expected at least to be maintained in 1960.

The oil-from-coal project reached a break-even point in 1959. This £48,000,000 enterprise will largely complete its consolidation programme—including new installations—by about the end of 1960. In 1959 the Corporation tended to pay greater attention to chemical by-product activities and developments. The torbanite refining company continued exploration to replenish its nearly exhausted mineral reserves without success, but expanded the refining of imported crude oil and had nearly completed negotiations with the major oil companies over future developments. The S.A. Carbide company re-organized and reconditioned its plant and reported keener demand for its product. Large-scale use of low-grade Transvaal coal was projected for the production of ammonia in a fertiliser plant.

Copper.—Operations were mainly directed towards improving producing facilities and potential and towards effecting economies and raising efficiencies. In one case electronic control equipment was installed in a mill. In the Letaba area, Northeastern Transvaal, pilot-plant runs were conducted on copper-zinc ore.

Iron Ore.—With export conditions improving in the closing stages of 1959 in respect of steel, pig-iron, and ore, production continued on the uptrend, particularly in the Sishen-Postmasburg area, Northern Cape. An influencing factor was the continued

implementation of the major expansion programme of the country's foremost steel producer.

Manganese Ore.—An important factor in the year's operations was the continued expansion of the domestic market and the consolidation and further extension of ferro-manganese output. Generally the export markets reflected highly competitive conditions and lower unit prices, even for companies with long-term contracts. A late improved outlook for exports did not hold out better price prospects. Mining rights were extended and new workings were opened up mainly to supply domestic producers of ferro-manganese. Rail facilities were expanded in the Postmasburg area, Northern Cape, to handle greater tonnages of both manganese and iron ore expected to be offered.

Phosphate.—One producer installed a washing plant to improve output at lower unit costs at its Cape deposits. The country's major producer in the north-eastern Transvaal modified and extended its plant, including the flotation section, and initiated exploitation of lower-grade zones in a programme aiming at doubling output and eventually satisfying all domestic requirements and possibly providing for some exports.

Platinum.—Despite a lower average price, quantitative sales of the platinum-group metals regained ground. With accumulated stocks reduced production was stepped up considerably, stocks were reduced, and aggregate profits improved substantially.

Tin.—An unexciting year saw exploratory and normal development maintained and producing facilities improved both underground and on surface, where plant modifications and new installations raised extraction efficiencies.

Miscellaneous.—Its contract ended and not renewed, the producer of monazite concentrates was placed on a caretaking basis. Plans were being formulated to produce titanium pigments from Umgababa Minerals production of concentrates, with production scheduled for 1962 in a 10,000 ton-a-year plant. Soda ash production at an annual rate of 120,000 tons was projected at the Sasolburg industrial sites, Northern Free State, near the oil-from-coal project. An extensive survey of the country's beryllium deposits was initiated. Bentonite was produced for the first time in 1959.

Diamonds.—Amending legislation to the Precious Stones Act, 1927, was tabled for enactment and provided for the clarification and improvements of conditions in respect of capital expenditure and working costs and for promoting the expansion of production and extension of exploration. The Adamant Laboratory of the De Beers group announced that it had successfully developed a process to synthesize diamond grit on an economic commercial scale. Any decision to embark on this would be taken in conjunction with Societe Miniere du Beceka of the Belgian Congo. Research continues.

For the South African diamond industry 1959 was largely a year of arrangements and agreements. Associated companies of the De Beers group successfully concluded negotiations for acting as marketing agents for Soviet diamond exports outside the Soviet sphere. Another associate agreed on arrangements whereby Engelhard Industries Inc. of the United States would establish a specific United States division for holding stocks, promoting sales of industrial diamonds there, and conducting relevant research. The same interests earlier established a Canadian company to expand the use of natural diamond abrasives and develop new applications. A De Beers associate negotiated a new agreement with the Sierra Leone Government to the end of 1964 for marketing the alluvial diamond production of the territory and to impart greater stability to trade therein.

The De Beers group extended operations in South-West Africa and especially in Namaqualand of the Northwestern Cape. In the Western Transvaal, another company had much improved development disclosures and prepared to expand production on a more efficient basis.

Acting on behalf of South African and other producers the Central Selling Organization of the De Beers group increased gem sales to £63,033,000 in 1959 from £49,420,000 in 1958, and sales of industrial stones to £28,102,000 from £16,123,000.

South-West Africa

A mining man of the territory, who long trod the lonely, dusty paths of prospecting, recently commented that "South-West Africa will smile again when the rains come," and, he might have added, will grin when the mining outlook brightens. In the 1959 mining returns of the territory features were few and far between. Gem diamond production and sales alone sparkled, but improvements were recorded in copper, lepidolite,

vanadium-lead concentrates, and the complex lead-copper-zinc concentrates in the aggregate sales value.

In the diamond sector, Consolidated Diamonds electrified and doubled its coastal rail facilities to accelerate and expand field-plant operations. A new continuous grease-belt recovery plant and diamond sorting house were commissioned. Consolidation rather than expansion was the keynote of exploration and prospecting. In the northern districts De Beers Consolidated Mines maintained its operations. A smaller producer—of industrial diamonds, the Industrial Diamond company—while not quite maintaining previous returns, was formulating plans to purchase a suction-cutter dredge in a programme to exploit a 12-mile terrace with estimated reserves of 4 mill. carats at an expected yield of about 7 carats per 100 cu. yd.

By selective operations Tsumeb Corporation—the producer of the complex concentrates—scaled down output of lead and zinc but raised copper and silver production. The corporation was erecting the first copper refinery of the territory for operation on a custom basis. The South West Africa Co., producer of vanadium-lead concentrates, stepped up operations at Berg Aukas where metallurgical tests and exploration were continued and a new flotation plant was commissioned. At the company's Brandberg West tin-wolfram deposits the plant has been modified to handle 20,000 tons a month of ore. S.A. Minerals continued limited production of manganese ore from development operations which were extended further in its extensive holdings. S.A. Iron and Steel Industrial Corporation was another of the major interests to stake a claim in the territory when it acquired the tin mine and mining rights of the now defunct Uis Tin Mining Co.

The Trans-American Mining Co. of Canada conducted an aerial magnetometric survey for oil deposits in the Walvis Bay-Luderitz area, extending 3 miles to sea. The oil rights were ceded by Diamond Mining and Utility Co., which retains a royalty.

Bechuanaland Protectorate

No new mines were opened up in Bechuanaland during 1959. Chrysotile asbestos production near Kanye, Bangwaketse Reserve, was continued but at reduced levels due to adverse marketing conditions. With improved conditions late in 1959 operations were stepped up again. On balance production declined to 1,410 from 2,265 short tons in 1958. The two manganese mines, respectively in the Bangwaketse and Bamalete Reserves, markedly stepped up output to 20,138 from 14,213 short tons in 1958. Both mines were installing heavy-media separation plants to beneficiate the grade, while the Bamalete company located new occurrences in the south-western area of the Reserve, from one of which the greater proportion of output was drawn. Gold production was not quite maintained.

No review of the mining activities of the territory would be complete at this stage without recording a tribute to the persistent efforts of the Geological Survey Department, which are now yielding appropriate reward and receiving due recognition. The more important mineral occurrences have now been examined by the Department, which in 1959 continued investigation of the potential coal areas, rendered assistance to operating mines, and conducted mapping and core drilling. The Department is now concentrating on accumulating knowledge of the basic geology and structure of the territory, fundamental to the assessment of its economic potential and to the production of geological map sheets. A coal area in the vicinity of Mamabule Siding on the Rhodesia Railways rail-line was tested by drilling in a 40 sq. mile zone, in which two relatively persistent coal zones were located, the shallower carrying a seam about 17 ft. wide and the lower zone a seam of 7 ft. of somewhat higher quality.

A Crown Grant was awarded to Consolidated African Trust covering diamond prospecting in Bamangwato Reserve and operations have been initiated. Another Grant was awarded over all minerals, except diamonds, in the Bakgatla Reserve to Marlime Chrysotile Corporation, which initiated joint prospecting with another organization late last year. Manganese rights were awarded to a private individual over an area in the Southern Crown Lands. Rhodesian Selection Trust received a concession covering all minerals excluding diamonds in the Bamangwato Reserve and active prospecting was scheduled from early 1960. Diamond prospecting rights over restricted areas of Crown Lands were also awarded. In addition, Crown Grants will probably also be awarded for prospecting rights over a large area of the Batawana Reserve. An application has been made for Crown Grants covering diamond

prospecting rights over a large area of the northern, central, and southern Crown Lands and over the five major Reserve areas in the southwestern Protectorate. Through Anglo American Corporation, De Beers Consolidated Mines continued prospecting in the Lobatsi block and completed exploration in the Gaberones block. The mineral rights in the two blocks are owned by The British South Africa Co. The outlook for mining activity in 1960 is certain in this respect, that there will be markedly increased prospecting activity (which may well lead to the discovery of important mineral occurrences in the future) and that known mineral occurrences in the Bamangwato and Bakgatla Reserves, in the southern Crown Lands, and possibly in the Batawana Reserve, will be investigated further.

Expansion of chrysoltile fibre and manganese ore output will depend on economic conditions.

Power Units for Mechanization

Leo Walter, M.Inst.F.

The author surveys a recent trend and looks to the future

Introduction

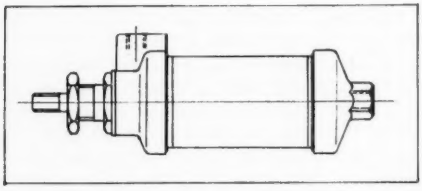
Progress in mechanization of mining operation has naturally resulted in the wider use of power units. Such range from small units developing fractional horsepower (as in signalling), in instrumentation, and as pilot units to large power units (as for pushing cylinders for use with armoured conveyors and power loading equipment). The use of hydraulic power units in plough and scraper-box installations, for example, has become widespread.

The mining engineer has to-day a very wide choice of power units to be used for plant mechanization. Pneumatically-operated power elements, hydraulic or hydraulic-electric units, and electrical equipment for producing linear or rotating motion are available in a variety of designs. The choice of a power unit depends on matching requirements from a piece of plant equipment (machine, conveyor, large valve, or damper, etc.) with characteristics of the power unit. Speed of motion, controllability of movement, load, torque, safety, ambient temperature, and many other factors have to be considered before specifying a design. For example, a hydraulic system may be in danger of freezing if used in the open. Where oil is the actuating fluid the danger of fire hazard may be present in case of leakage. Electrically-operated hydraulic power units have to be intransically safe if used in explosive atmospheres. An air-operated system may work well in one instance, but may be less suitable where great distances of piping are required. On the other hand, should an air leak develop this would be less troublesome than a leak of hydraulic inflammable fluid piping.

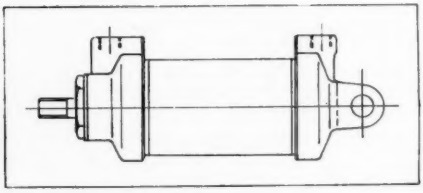
In the following brief survey a few characteristics of the various systems will be dealt with and some hints on trouble-shooting will be given.

(*Sutcliffe*)

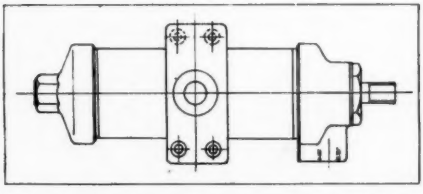
Power Cylinder.



Double acting neck mounted air cylinder.



Double acting rear trunnion mounted air cylinder.



Double acting centre trunnion mounted air cylinder.

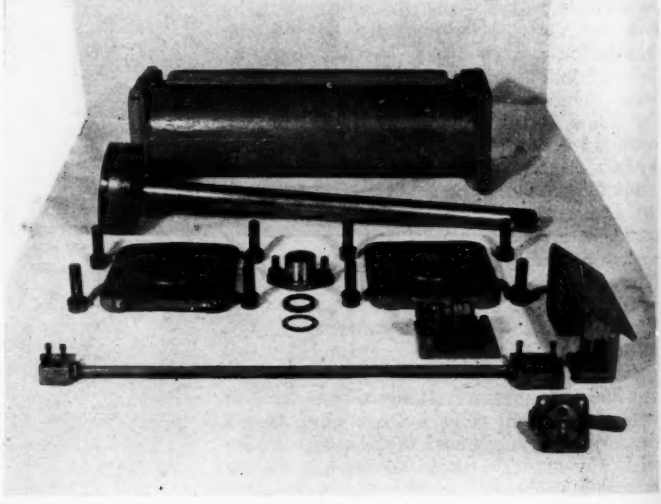
Pneumatic Power Units

Development of pneumatic power equipment has been vigorous during the last two decades. Manufacturers of air-control valves, of pneumatic power cylinders, and of other pneumatic gear have greatly improved the design of such units, while users have also shown considerable ingenuity and skill in their practical applications.

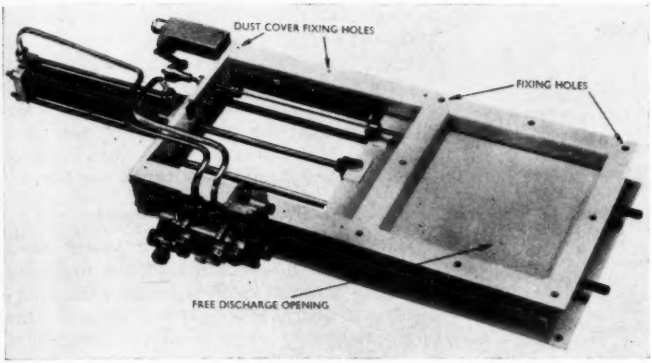
The design of pneumatic control valves is a large subject. Where small volumes of air have to be controlled the use of miniature valves as pilots has become universal. These pilot units, being compact in size and shape, are usefully employed in smaller mechanisms of all kinds. Electrically-operated solenoid valves are made in two-way, four-way, and multiple-way types. The use of a low voltage (about 8V) with current from a step-down transformer has become widespread; rectified supplies offer certain advantages.

Pneumatic power cylinders are available in such variety that most requirements can be met by standard types, where moderate power is required. Modern air-power cylinders have an integral construction of air control-valve and cylinder-body. This design not only saves air in every operation, but also eliminates lengthy connecting piping between air valve and cylinder, because only a single air hose is required. Two, three, or more air-power units can be electrically interlocked by using solenoid valves; they then work in

Exploded Power Cylinder.



(*Mavor and Coulson*)



Pneumatically Operated Slide.

exactly-timed sequence to perform related operations.

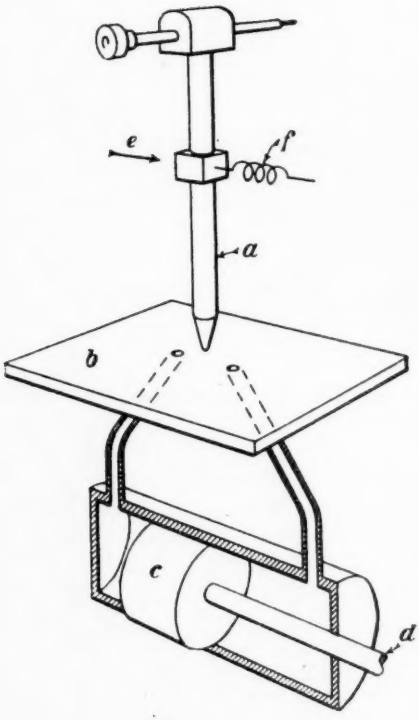
A new and improved version of electro-pneumatically operated slides for material flow control has been developed by a specialist firm.[1] The units are of robust fabricated mild steel construction and complete with air cylinder, solenoid-operated air valve, open-and-closed position detection switch, and an air release valve for emergency hand operation and maintenance. The design precludes the possibility of jamming by the elimination of guides, the slide plate bearing on rods when mounted beneath conveyor outlets and on rollers when mounted at bin or mixer outlets ; easy fixing is ensured by its double flanged construction. Six standard sizes range from $4\frac{1}{2}$ in. by $4\frac{1}{2}$ in. to 18 in. by 18 in. and they are available as single units or as part of complete control installations. Special sizes and fully dustproof versions are also available.

When contemplating the installation of pneumatic power units compressed air delivered from a more or less elaborate air-compressor plant is required. As is well known, the force of an air cylinder can be calculated by multiplying the cross-sectional area of the piston by the air pressure in p.s.i. About 20% to 25% should be deducted from the figure to allow for friction and other losses. The main point to watch is to avoid overload on cylinders. The use of levers or cams for augmenting power from an air cylinder should

[1] Lindars Automation, Ltd.

Application of Power Cylinder.

(Mavor and Coulson)



Oil-Jet Control Mechanism.

be avoided. The simpler the system design the less trouble can be expected. In recent years hydro-pneumatic units have become available. Oil is contained in the front section of a double-cylinder unit. The rear section has air admission. Strokes and diameters of these unts are available from makers as for standard pneumatic cylinders.

Advantages and Limitations.

Air-power units ordinarily have a lower ratio of inertia to peak thrust than geared electric drives. The advantage over oil units is that if air as an elastic fluid is used for prime-mover power generation excessive chocks in piping are avoided. Pressure drops in pipes are proportional to the square of volume flow and the fluid density. High air-flow volumes give, therefore, much less pressure drops than when using oil. This means smaller air pipelines, smaller relay systems, and smaller valve porting for control elements. Compressed-air receivers have also advantages over hydraulic accumulators and are lower-priced.

Limitations of compressed air as power and control fluid are as follows :—For high-speed control over long distances the capacitance characteristics of air transmission can be a limiting factor. Very high pressures for large loads may be better for hydraulic systems.

Hydraulic Power Systems

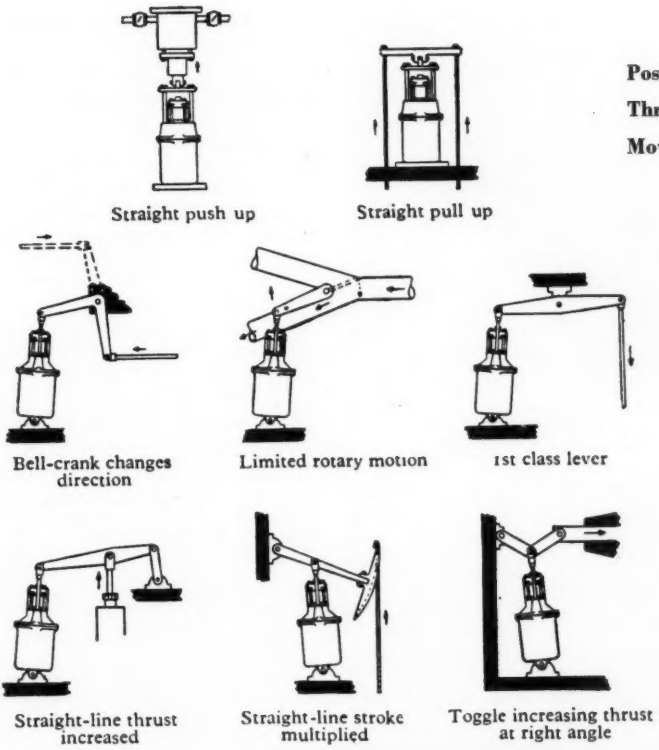
Manufacturers of hydraulic power units for industrial uses claim that the flexibility and adaptability of standard hydraulic equipment is a desirable economical feature. The fact which they stress is that a liquid-filled pipeline is a simpler connexion between power units in a system than linkages often used in mechanical transmission. No lubrication is required, as must be used for mechanical gear, and maintenance is simple.

Hydraulic control gear is available as standard elements for producing constant or variable torque over wide ranges of speed. Fluctuating loads can be dealt with by proper arrangement of control valves. Stoppage or reversal of hydraulic motors can be achieved almost instantaneously without undue shock loads. Positive interlocking of operational sequence is easily achieved. This is of great importance for instances where automatic cycles are applied to mechanical-handling operations. It is claimed that power economy for large hydraulic systems is very satisfactory. Main pumps may be arranged so that they only operate under load until rams come into operation. By using a direct-pumping system the pump will develop only such pressure as to overcome the resistance imposed by the job.

Electro-Hydraulic Systems.

The use of electrically-driven pumps for producing oil pressure has become standard. Very compact motor-pump-oil tank units have been developed in recent years. For example, in modern automatic process control electric signals actuate hydraulic-power cylinders. The well-known oil jet-pipe principle is used in electro-hydraulic systems for boilerhouse control and other applications. The hydraulic power generating unit is an oil pump producing oil under pressure. With electric signals the impulse unit is an electro-magnetic head. This unit converts the electric signal into a force operating a jet-pipe unit.

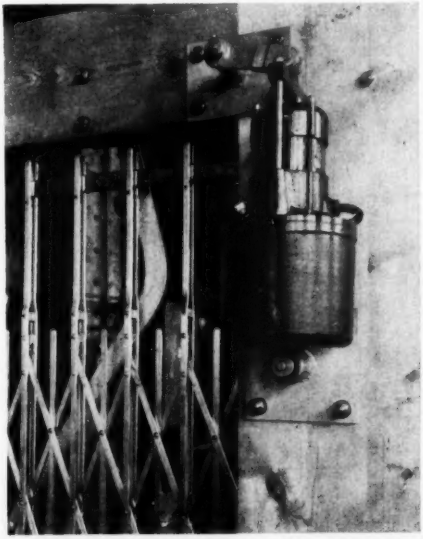
Very large power cylinders can thus be actuated from minute electric signal impulses.



Possible Thrustor Movements.

Electro-Hydraulic Thrusters.

Among modern electro-hydraulic power units the B.T-H. Thrustor, made by Associated Electrical Industries (Rugby), Ltd., is probably amongst the most widely-used large power elements. B.T-H. thrustors are self-contained units, which are also available in flame-proof designs. They consist of an impeller motor, the shaft of which is extended to carry an impeller. This centrifugal impeller pumps oil from an upper chamber in a vessel into a lower chamber. In the latter a piston moves when subjected to oil pressure. When the motor stops the oil flows back, thus allowing the piston to return quickly. The design has been worked out to exert a smooth, straight-line, constant-pressure thrust to any mechanism it is desired to operate. The range is from 40-lb. thrust, 2-in. stroke, to 800-lb. thrust, 12-in. stroke, divided into nine thruster sizes. Applications of interest to the mining industry are, amongst others: Operation of conveyor loading or unloading gear; on brakes for heavy equipment; for movement of very large valves or dampers;



Gate Control by B.T-H Thrustor.

(*Sutcliffe.*)

Rod Guard.

operating butterfly valves using flame-proof thruster design; operation of friction clutches; for remote control of lattice gates in mining; operation of heavy slide or swing doors; operation of gear-change mechanisms. In its application to the well-known B.T-H. "Stacreep" system, the thruster is used to release a spring-applied shoe brake. The latter is of special type embodying main and control springs. Slight variations of thruster pressure vary the braking torque efficiently. Stacreep-controlled brakes are used on hoist systems in many crane designs and the like.

Pushing Cylinders in Coal Mining

The National Coal Board has made special investigations of the use of pushing cylinders, part of which is reproduced here by permission, from Information Bulletin No. 58/199, which points out the increased use of hydraulic circuits in British coal mining. The following observations and recommendations are taken from this highly-informative brochure and should be of interest in mining operations anywhere and for different materials.

Power Supply.

Pressures for operating compressed-air pushing cylinders vary between 60 lb./sq. in. and 80 lb./sq. in. The air can be supplied either from a main compressor unit or from an inbye compressor and is taken along the face through steel pipes or flexible hoses fitted with tee-pieces for each cylinder connexion.

In the case of hydraulic cylinders the fluid (in the form of oil, or oil and water) is generally provided by a unit comprising an oil tank and an hydraulic pump (complete with drive), conveniently situated near the face. Operating pressures vary, depending on power requirements, up to the maximum working pressure for which the cylinder is designed. Fluid lines can be either steel pipes or high-pressure flexible armoured hoses, similarly equipped with tee-pieces for each cylinder connexion.

Two fluid circuit systems are in use—the "open" and the "closed" circuit. In the open circuit (little used) only one pressure line is required to supply fluid to each cylinder, the exhausted fluid being discharged through a short hose on to the floor of the seam or on to the conveyor. The disadvantages of this system are—the discomfort caused to workmen, the action of the discharged water causing soft floor

Cylinder Coupled to Power Lines.

(*Sutcliffe*)

to break up (resulting in prop penetration) as well as the necessity to refill the tank frequently due to the loss of fluid.

With the closed-circuit system an additional fluid line is required to return the discharge fluid to the tank. This system is essential in all installations using oil as the hydraulic medium. Recent experience has shown that for quantities up to 5 gal./min. the high-pressure line should have an internal diameter of not less than $\frac{5}{8}$ in. and the internal diameter of the return line should be not less than $\frac{3}{4}$ in. Consideration should therefore be given to future requirements when ordering transmission lines. An N.C.B. specification is in course of preparation dealing with hydraulic hose and couplings.

Choice of Cylinder.

If a colliery is served by compressed air to the face the obvious choice would be to instal compressed-air pushing cylinders; nevertheless, hydraulic cylinders may be used, the trend being to use this type even if compressed air is readily available. The governing factor should be the total thrust required to move the equipment with the normal (5-yd.) cylinder spacing. The thrust required will depend on the nature of the floor and the type of equipment to be moved over; some armoured face conveyors can be moved over with a thrust at each cylinder of only $1\frac{1}{2}$ tons, whereas others require $2\frac{1}{2}$ tons. Generally the following factors should be taken into consideration in choosing the type of cylinder: (*a*) Seam thickness; (*b*) method of attachment to the conveyor; (*c*) method of attachment to the power line; and (*d*) overall dimensions. In seams exceeding 3 ft. the movement of workmen along the face is not so much affected by the height of the cylinder, but below this thickness advantage should be taken of those types of pushing cylinder which afford least obstruction.

Armoured Conveyors.

Armoured conveyors have a tendency to creep towards one or other end of the face, thus altering the position of the pushing cylinder in relation to the supports. The method of attachment should therefore be one which allows the cylinder to be moved sufficiently for the props to be set in the correct position.

Pushing cylinders are designed for connexion to the conveyor either by the cylinder or by the piston rod. Generally, the former method has certain advantages in that, as the cylinder moves forward with the conveyor, it is less likely to be buried by goaf debris; also, hoses are normally shorter and the valve as well as the various connexions are better protected.

To avoid bending of piston rods, attachments should give adequate facilities for movement in both vertical and lateral planes so that pushing cylinders can align themselves in the direction of thrust. In steeply-inclined seams, however, and when using pushing cylinders with air connexions at the piston-rod end, the pivotal movement should be restricted, otherwise the cylinder will pivot to the dip and, as a result, air hoses may burst.

It is good practice to arrange each cylinder so that the thrust is in the centre of the conveyor or guide rail. Compressed-air cylinders, by reason of their larger diameter, usually comply with this but some hydraulic types (depending on the height of the cylinder ends) will require either to be elevated so that the cylinder is parallel to the floor, or placed directly on to the floor and attached to the conveyor by a bracket.

Power Line.

The method of attaching a cylinder to the power line depends on the design of the cylinder and may be by short hose lengths to tee-pieces; alternatively the cylinder is coupled directly into and forms part of the power line. The former is preferable, to allow movement of the cylinder.

It is an advantage if the short hoses are provided with self-sealing couplings so that, in the event of a cylinder breaking down, these can be changed without the other cylinders being affected.

It is conventional to refer to the piston-rod-entry end as the " front " of the cylinder and the opposite end as the " rear."

Dimensions and Stelling Arrangements.

The length of stroke, design of the cylinder ends, and the positioning of the valve are factors which influence overall dimensions; when choosing a cylinder these items should be taken into consideration. It is important that the cylinder should not be longer nor higher than necessary; also it should, at all times, operate within the supported-roof area and should be clear of the pack walls or waste edge. It is also important that the advantage of small-diameter cylinders should not be lost by cylinder-end covers of excessive dimensions and that the cylinder should have a streamlined appearance so as to cause as little obstruction as possible.

It is preferable that a pushing cylinder should be connected to the stell prop by a cradle located at some intermediate position, rather than directly attached at the goaf end, since in an intermediate position there is less tendency for the piston rod to bend. In an intermediate position the stell prop usually acts against a sound roof and the overall length of the equipment is reduced. It is an advantage to have the stelling device attached to the cylinder so that it moves forward when the piston rod is retracted. A further advantage of the cradle-type stell arrangement is that it offers more resistance to a soft floor.

This arrangement is suitable only if the seam is thick enough (say 3 ft. or over); in thin seams the mobility of the workmen would be restricted. Telescopic stell props are particularly useful where there are variations in the seam thickness. Tables " A " and " B " from the appendix of the N.C.B. Information Bulletin are reproduced with permission and give details of various makes and designs of power cylinder units.

Trouble-Shooting on Hydraulic Systems

As the result of extensive investigations on the part of makers and large users of hydraulic power units in systems using liquid fluid for movement and control the following causes of failure have been found :—Leakage of the power fluid seems the biggest maintenance problem. This is followed by development of sluggishness, noise, and varying fluid pressure at the point of use. Sometimes excessive vibrations of piping seem to cause leaks in a system. Excessive heat has to be avoided, because it may make the oil thinner, giving

cause to increased leakage. When investigating trouble the above causes must, of course, be eliminated. The main cause for repairs seems to be wear-and-tear of seals in valves and in power cylinders. Certain types of pumps are vulnerable to wear and tear of moving parts, gaskets, and the like. Free flow of the fluid should be supervized by fitting of flow indicators in the piping system. Special flow indicators are on the market for high fluid pressures, using a rotating impeller within a pipe piece. Its motion is electronically transmitted to an indicating instrument.

Intermittent trouble sometimes suggests air or foreign matter in the oil system. To use pipeline strainers in elaborate hydraulic piping systems is highly advisable. To use best suitable special oil, which is clean and preferably not inflammable, is very important. The cause of erratic operation of a hydraulic power unit (cylinder, torque motor, etc.) may be sticking plungers of solenoid control valves or sticking control-valve seats. Where broken valve springs are repeatedly causing trouble either their material or design is wrong. Dirty oil-pump strainers are usually indicated by a noisy pump. Regular inspection and cleaning of hydraulic power and control units is important. A well-planned hydraulic system using well-designed power units will seldom have all the above troubles together. Planned maintenance will defer development of each single trouble for a long time. This applies to hydraulic and electro-hydraulic units and piping systems as well as for pneumatic systems.

The Present State of the Witwatersrand Controversy

A review of recent research

C. F. Davidson[1]

Some Geological Considerations

In a recent discussion of Witwatersrand problems, C. W. Pegg (1959) concludes an attack on hydrothermalist arguments with the words : " Geology has always been and probably always will be an inexact science. Field observations and relationships that are obvious to the naked eye and to good old-fashioned common-sense should be accepted in preference to geochemical evidence and to age determinations, since the rocks and minerals concerned have generally been subjected to many later metamorphisms. Geologists of to-day are forgetting the importance of field evidence." Elsewhere he refers to " armchair observers in other lands who are in the main hydrothermalists " and deplores that " of late it has become standard practice to solve geological problems by turning to microscopy, geochemistry, age determinations, and the like, in preference to field evidence. In some instances seemingly authoritative papers have been written entirely on the examination of specimens without the writer having visited the area or even the country of origin." In the specific context in which these criticisms appear they are directed personally at the writer. Doubtless they would not have been made had the critic kept in mind that, whilst he himself was making his field observations in the Witwatersrand with the aid of good old-fashioned common-sense, regardless of the existence of uranium in the ore he was mining, the " armchair observer " had already gone some way towards pioneering the South African uranium industry. Likewise the critic has forgotten that it was the geochemical evidence which led to the sinking of the first drill-hole at Blind River ; and that the " armchair observer's " assessment of this field, for H.M. Treasury, was auxiliary to the first major financing of development there. Were it not for the armchair observers (some of them more often air-borne than chair-borne) quite a few geologists who rely on good old-fashioned common-sense would be out of work.

The trouble with good old-fashioned common-sense is that it is not always free from prejudice. For example, Pegg (1959) writes : " The fact that ore minerals [in the Witwatersrand] are confined to certain conglomerate bands, in places only half-an-

[1] *Concluded from the March issue, p.* 159.

inch thick, suggests that the ore was deposited in these horizons by placer processes." But a few paragraphs further on, he asks : " If the conglomerates were deposited on a subsiding continental shelf, as seems likely, then how did the pebbles get out that far, and how was the gold transported to this locale ? " Is not this an admission that the " commonsense " interpretation rests on no more than an article of faith ? Fortunately the validity of this credo can now be tested. The touchstone is to be found in the very researches on sedimentation which Pegg himself wisely advocates as the fundamental need in the banket ore-fields.

The pioneer researches on the sedimentary petrology of the Witwatersrand System lately completed by A. O. Fuller (1959*b*) bring to discussions on the alluvial genesis of the ore-bodies an element of precision that has hitherto been lacking. These studies demonstrate *inter alia* that, according to 1,500 measurements conducted on 31 representative specimens, approximately 80% of the detrital quartz fraction in the quartzites of the Upper Division of the Witwatersrand consists of angular single crystals having an average diameter of 1·4 mm., with a mean deviation of 0·6 mm. Side by side with these figures let us set down the conclusion of Liebenberg (1956), based on 25,000 measurements, that the average diameter of the rounded pitchblende particles (Ramdohr's so-called " pebbles ") in the Witwatersrand ore is 75 microns, with a range from 10 microns to 200 microns. Statistics on the size of the gold grains are less precise ; but according to Liebenberg the particles of allogenic or primary gold " frequently occur in the matrix as minute specks, about 0·005 mm. across, but they are usually about 0·05 mm. across." Let us forget about the minute specks and take the latter figure, 50 microns, as the average size of the " detrital " gold grains. Thus :—

	Quartz	*Uraninite*	*Gold*
Average diameter, microns . . .	1400	75	50
Specific gravity . .	2·6	9	17

Assuming the particles are spheres, they settle at a rate expressed in the formula of G. G. Stokes (1851), namely $V = 2gr^2(d_1 - d_2)/9n$, in which g is the attraction due to gravity, r and d_1 respectively the radius and density of the particles, d_2 and n the density and viscosity of the fluid. By calculation, it becomes apparent that the rate of settling in water of the average quartz grains in the Witwatersrand quartzites is 70 times speedier than that of the average particle of uraninite or of gold in the bankets. Why, then, if the uraninite and gold are detrital, should they preferentially accumulate in high concentration solely or principally within the conglomerates ? That they do so, contrary to the elementary principles of sedimentation, is an eloquent demonstration that they cannot be alluvial.

The same arguments are applicable to the ores of Blind River where, though precise data are lacking, the feldspathic quartzite of the Lower Mississagi is of coarse to conglomeratic grade (McDowell, 1957). On the principles of alluvial deposition it is not possible to explain the great concentration of minute particles of uraninite, brannerite, and sulphides almost wholly within the conglomerates, when the relatively barren wall rock is built up of quartz grains more than a thousand times heavier than the grains of ore mineral.

Passing to other matters, we find in the writings of L. T. Nel (1958), and in various other contributions of lesser significance, a host of geological arguments marshalled in favour of the syngenetic hypothesis. Insofar as these contentions relate to general problems of mineralogy and geochemistry, they have already been rebutted elsewhere in this paper. Insofar as the arguments are based on details of South African geology, the writer enters the lists handicapped not only by a lack of local knowledge but also by a profound admiration for the works of his amiable adversary. At most, he can but try to demonstrate that the views expressed by Nel warrant some reconsideration.

One much-quoted polemic should be disposed of first. Nel concludes his review with the words : " Collectively, the criteria available definitely favour the modified placer hypothesis. To quote MacGregor, the unfailing principle of sedimentary control has guided the underground development of the mines and has yielded dividends beyond compare in any other part of the world." But the sedimentary control of the principal deposits has never been at issue. Fortunately for the employment prospects of the Rand's army of samplers and analysts, sedimentary control is not synonymous with sedimentary deposition. It does not strengthen the placerist case to rest it on a misapprehension.

The geological arguments in support of the placer hypothesis are, in Nel's words, summarized as follows : (*a*) The intimate

connexion between the distribution of the ores and the sedimentary characters and structures of the host rocks ; (*b*) the absence of known feeder channels and of a magmatic source for hydrothermal uranium- and gold-bearing solutions ; (*c*) the fact that mineralization does not transgress across surfaces of stratification or follow planes of fracture ; (*d*) the presence of uraninite and gold in some of the Witwatersrand reefs at the time they were cut by intra-formational stream channels ; and (*e*) the occurrence of boulders of impervious, cemented Witwatersrand quartzite and ore-bearing conglomerate in Ventersdorp boulder conglomerate and volcanic breccia.

That there is a control of mineralization by the sedimentary characters and structures of the host rocks is accepted by all. What to one investigator is a syngenetic control by alluvial processes is to another a control of epigenetic fluids by permeability. On this matter Nel raises only one new issue. " No evidence has yet been presented to prove that the ore-bearing conglomerates of the Witwatersrand system, which form only a very small part of the total conglomerates in the succession, actually possessed a permeability superior to that of the latter, the lithological character and texture of which suggests that they must have been as permeable, if not more so, than the ore-bearing conglomerates." But we are told by Brock (1954) that " the gold-bearing conglomerates are composed of more resistant pebbles. Conglomerates with varied pebbles of mixed compositions and shapes are not usually the gold carriers " ; and much the same distinction is made by many other authors. Surely it need only be remarked that oligomictic conglomerates, typically the product of a marine transgression, are almost invariably characterized by good sorting and *ipso facto* have a particularly high permeability ? The better permeability of the quartz-pebble reefs can be explained readily enough. It is quite another matter (maybe one which Nel has not considered) to explain how the friable " detrital " uraninite managed not only to survive, but also to concentrate preferentially in those very reefs which had the maximum amount of natural milling.

Reviewing at length the possibility of a magmatic source for the mineralization, Nel comes to the conclusion that " detailed geological mapping . . . has not revealed the presence of a large body of igneous rock that has invaded the Witwatersrand System and formed the reservoir for uranium- and gold-bearing solutions." Even without consideration of all the evidence on age determinations, this seems a remarkable verdict. Presumably not even the most ardent placerist would disagree with Swiegers (1949) that the flat auriferous leaders and transgressive veins permeating the Transvaal sediments in the Pilgrims Rest region are of hydrothermal origin, linked to a post-Transvaal (probably Bushveld) granitization. But if a Bushveld-age granite can give rise at shallow depth and under conditions of tension to the gold lodes of Pilgrims Rest, should we not look to a granite of the same age as the source of the mineralogically similar ores of the Witwatersrand, perhaps formed at greater depth and under conditions of compression ? Nel objects that there are no known occurences of uranium-rich minerals associated with the Bushveld granites. The Limpopo granitization is radioactive enough for it to have been regarded by placerists as the primary source of the Rand uraninite (Liebenberg, 1956a, p. 177)—until it was proved to be of Bushveld age ! It is radioactive enough, in places, to have been staked and prospected as uranium ore ; and like many of these younger granites it gives locally on weathering a fluorescent crust of uraniferous chalcedony. Contemporary with these granites, the Palabora carbonatite is the most uraniferous complex of this kind in Africa. Again, whilst it may be argued that the flat leaders of Pilgrims Rest differ from the Witwatersrand ores in containing no uranium, the recorded presence of carbonaceous matter in these veins is suggestive of thucholite. The geochemical link-up of the banket mineralization to the Bushveld granites is thus quite in keeping with the evidence from geochronology.

Since so many of the long-established concepts of Witwatersrand geology, based upon careful field work, have lately had to be discarded in the light of recent laboratory studies it seems not unreasonable to suggest that the remaining geological evidence for the fundamental arguments of placerism should be carefully reviewed. As exceptions to the general rule that " seeing is believing " there are instances where it may more appropriately be said that " believing is seeing." For example, as recently as 1955 Nel, in a letter to the writer, observed : " Detailed regional mapping by the Geological Survey of the country between Zoutpansberg and the Limpopo River shows

clearly that the Limpopo granite, and the Messina sediments and other old rocks which it has invaded, are Archaean, and thus older than the Witwatersrand System. Resting on an old uneven land surface of these Archaean rocks are also some patches of what has been mapped as Dominion Reef System." Would the same conclusions be reached to-day when we know that the Limpopo granite is of Bushveld age?

The arguments (1) that mineralized boulders of silicified Witwatersrand conglomerates occur in the Ventersdorp boulder bed and volcanic breccia; (2) that mineralized banket reef is cut by barren intraformational stream channels; and (3) that the mineralization is wholly of a non-transgressive character, rest wholly on field interpretations. On the first point there is some evidence that the Witwatersrand pebble-beds were compacted to conglomerates before mineralization took place, in that rich uranium ore is often found along foot-wall and hanging-wall partings, and along internal bedding planes, with poorer developments where the walls are frozen. Such a distribution is inexplicable on the placer hypothesis. It is, therefore, quite possible that boulders of conglomerate could be shed into overlying strata at major unconformities; but this is not at all synonymous with an admission that silicification and mineralization pre-dated the erosion of the reefs. In adducing the other arguments, it seems that the mine geologist is much hampered both by the unnatural classification into payable ore, unpayable ground, and barren rock imposed by commerce and by the limitations of commercial analysis; and the remote critic can scarcely be expected to accept the numerous undocumented pronouncements of the field men whilst they still dispute whether the bankets are deltaic, continental, glacial, or marine. Many occurrences of pyritic quartzites have been recorded in erosion channels of the Main Reef, Main Reef Leader, and other reefs; and Liebenberg (1956*a*) notes that small amounts of gold and uranium occur in these channels. "The gold is erratically distributed but it is profitably extracted in some areas." Clearly, therefore, the intraformational stream channels are not always barren, nor is the mineralization invariably non-transgressive. Arguments based upon the distribution of "waste" and "barren rock" are erected on the false floor of local economics rather than on a firm foundation of geochemistry. Thus in the most recently published account (Antrobus, 1957) purporting to demonstrate erosion and redeposition of gold contemporary with reef formation, what is referred to as "internal waste" averages in the 15 assays quoted about 40 grains per ton, many times the grade of a good placer ore. In the writer's view all these distribution patterns, together with the reputed alluvial reworking of gold and platinum along overlaps and unconformities, can be explained by local variations in bedrock permeability and by local variations in the metal content of the hydrothermal fluids, such as would give no special cause for conjecture in veins, skarns, or hydrothermal deposits of any other form.

Among the other geological arguments advanced against hydrothermal metallogenesis, the last to merit serious consideration is the contention that the banket reefs must be alluvial ores since they show no sign of the zoning characteristic of hydrothermal ore-bodies (Bosazza, 1959*b*). This tenet presupposes that zoning is a necessary feature of hydrothermal mineralization. But there is no zoning in, say, the Calumet and Hecla copper conglomerate, mined for 18,000 ft. along the strike and 9,000 ft. down dip. Nevertheless the writer believes that closer study of the banket fields will disclose some signs of regional mineralogical zoning which have yet escaped recognition. At Blind River there is observed to be a gradual increase in brannerite and monazite, with a concomitant decrease in uraninite, as one proceeds from the south to the north of the field; and this is strongly suggestive of a passage from mesothermal to hypothermal conditions. Roscoe and Steacy (1958) note that:—

> Ores that contain much uraninite . . . contain smaller amounts of the other minerals [brannerite, monazite, etc.] possibly excepting pyrite. . . . This relationship could be interpreted under the placer hypothesis as indicating that detrital grains of uraninite, which is very heavy, were deposited where currents were still vigorous enough to carry away most of the lighter heavy minerals such as zircon."

If this is so, how does it come about that the uraninite remains associated with the less dense "detrital" pyrite? Such claims seem to betray a lack of understanding of the placer environment so confidently adduced for these deposits. The optimum fractionation of heavy minerals under alluvial conditions is to be found on tropical black-sand beaches with a strong alongshore drift, but even here no significant lateral partition is found. Mineralogical analyses of seven representative

samples collected at mile intervals along the famous heavy-mineral shore sands of Kerala show figures for the ratio of sillimanite to monazite (whose specific gravities in water are in the ratio 1 : 2, as brannerite to uraninite) which are : 3·0, 1·8, 4·7, 7·0, 7·0, 1·4, 3·0. For kyanite to monazite (ratio of sp. g. = 1 : 1·75) the comparable figures are 2·9, 1·0, 1·2, 2·5, 0·6, 0·4, 0·6. The regional distribution of uraninite and of brannerite and monazite cannot, therefore, be explained by hydraulics. It is more likely to be a feature of the initial geochemistry of the mineralization, probably attributable to geothermal zoning. Similarly it may well be that mineralization in the Dominion Reef, richer in monazite and poorer in pyrite, was emplaced at a somewhat higher temperature than that of the Witwatersrand proper.

In the recent translation of Ramdohr's first monograph lately published by the Geological Society of South Africa, we find the concluding remark that " Davidson himself has emphasized that all the geological investigations, interpretations, and prophecies which have been made on the Witwatersrand have been carried out on the tacit supposition of sedimentary origin of the mineralization and have obviously met with the greatest success." In making this self-comforting assertion the neo-Wernerist of Heidelberg, like many of his South African colleagues, fails to appreciate that there is a very great difference between sedimentary origin and sedimentary control. No statement at all compatible with the above quotation has ever been made by the writer, who on the contrary (1954) has emphasized that " most of the early geologists who opened up the field favoured a hydrothermal hypothesis. . . . Insistence upon placerism probably greatly delayed the recognition of the uranium potentialities of the reefs." The successful development of the field has nothing at all to do with placerism, but is dependent in essence on two factors : the recognition of a sedimentary control of the mineralization (this being the one common ground between the twentieth century neptunists and plutonists) ; and the direction of mining operations according to assay results, with a greater number of assays per unit of ore than in any other large mining field in the world. Similar development guided by hydrothermal reasoning could not have produced less gold. It might well have yielded more.

Conclusion

Although the many recent studies referred to in this essay have, almost without exception, favoured a syngenetic origin for the banket ores, nevertheless a critical appraisal shows that the new evidence strongly supports the hypothesis of epigenetic mineralization. Geochronological researches utilizing many new techniques have revealed that the uraninite, and the monazite associated with it, are contemporary with the Bushveld granitization, post-dating the deposition of the reefs. Comparisons with true placer deposits have failed to reveal any alluvial analogue of the bankets anywhere within the stratigraphical succession. Geochemical arguments strongly favour a hydrothermal mode of ore genesis ; and mineralogical studies demonstrate that there has been widespread metasomatic alteration of the rocks of the Witwatersrand geosyncline. Geothermometric researches suggest that these rocks were subjected to mesothermal temperatures at a period post-dating the Ventersdorp volcanism ; and mineragraphic observations can be best interpreted as indicating a hydrothermal metallization later than Black Reef times. From all these works the firm conclusion can be drawn that the Witwatersrand mineralization is a product of the Bushveld magmatism.

That the hydrothermal hypothesis now rests on a sounder foundation than it ever did before is due to the diligence, care, and ingenuity with which the South African workers have pursued their researches. If the epigenetic irritant implanted within the Witwatersrand oyster has in the course of time given rise to the pearl of truth, let it not be forgotten that the layers of nacre are a true syngenetic product of the Transvaal, none of them more lustrous than the recent South African studies which the writer has here been privileged to review.

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Ore-Dressing Notes

(7) *Grinding.*

Pebble Milling on the Rand

The milling of Rand banket ores by pebbles began over 50 years ago, when flints were imported from Denmark to grind stamp amalgamation tailings, but it was soon found that selected ore pebbles could be used for the work. The pebbles used to-day are usually barren. With wide reefs there is no difficulty in selecting large pebbles for the primary grinding, but with the narrow reefs found in the newer fields primary grinding may have to be done in ball- or rod-mills.

Discussing current practice at Union Corporation mines Dr. O. A. E. Jackson [1] notes that the current trend is to increase surface head storage and to allow for extensions in the milling and cyaniding sections of the flow-sheet. Conveying, washing, and screening is usually laid out in its final form with extra space for further crushing equipment, crushing working on one shift only in the early years of production. A second shift can be introduced as the mining rate increases, but since crushing and milling are permitted on week days only on the Rand, while the cyanide extraction works continuously, mill pulp must be drawn down from thickeners where the extra supply is built up during the crushing week. Automation and labour-saving devices are now used wherever possible, while hydrocyclones fed from steady-head boxes rather than directly from pumps have replaced mechanical classifiers. Protective stationary screens are used to avoid choked cyclone spigots, a change being made from metal to rubber-lined pumps below three-mesh pulp.

None of the Union Corporation plants uses gravity concentration. Their studies show that this complicates the milling process and, together with the extra precautions necessary against theft, is not economically justifiable. Incoming feed is jaw crushed and then washed and screened, the washings being classified, thickened, and pumped to the milling section to join the feed to the secondary circuit. Native labour hand-picks waste quartzite and shale down to 3-in. size from conveyor-belts which move at 80 ft. per min.; 10% of run-of-mine ore is removed at an average man-rate of 10 tons per shift. Primary pebbles are to-day sorted off by hand, but in future plants they will be taken out by vibrating grizzlies or screens, secondary and tertiary pebbles already being separated in this way. They are moved on mine cars or conveyor-belts to the mill. Meantime the remaining 80% of the feed is given two stages of crushing, bringing it to about 95% *minus* $\frac{3}{8}$ in. in the newest plants.

The problem of feeding pebbles into the pebble-mills from the storage bins has not yet been entirely standardized. Conveyors, pan feeders, vibrating feeders, and roll feeders are used for an 8 ft. by 16 ft. mill, pebble consumption approximating between 1 in. and 3 in. of load shrinkage per hour measured from the mill axis. The load level is kept as steady as possible by means of a meter on the control panel; this tells the mill operator when to add more pebbles to maintain the power at its maximum.

An electronic feeder control has now been developed by Union Corporation. Before 1930 pebble-mills were 20 ft. to 22 ft. long and between $5\frac{1}{2}$ ft. and $6\frac{1}{2}$ ft. in diameter, but in 1948 two 21 ft. by 16 ft. mills were installed at Grootvlei. These have been proved cheaper in capital cost per ton of *minus* 200-mesh overflow product. Ten of these mills are now at work for the group. There is a tendency to revert from the centre drive mill introduced in the late 1930s to the conventional spur and pinion system, but all mills are low discharge with internal screens and lifter scoops. Feed is through hoppers fitted with heavy rubber gaskets and the assembly is spring-loaded so as to press against the rotating mill trunnion; gaskets last between a few months and a year. Liners

[1] Pebble Milling Practice at the South African Mines of the Union Corporation, Ltd. *Min. Engg.*, Nov., 1959.

for these mills are either of white cast iron with a Brinell number of about 227, cast manganese steel with a Brinell number of about 285, or of rolled steel bars with a Brinell number of 183. The steel bars form the Osborn bar liner. Solid white-iron liners 3 in. to 4 in. thick are heavy to handle and sometimes fracture prematurely. Manganese-steel grids with backing plates are lighter and more economical. The grids are open-work castings which pack the grinding medium solidly. They are backed by $\frac{3}{4}$-in. plates which protect the shell when the grids finally wear too thin to maintain their packing pebbles. Osborn bars are generally used in primary and secondary milling and white-iron blocks in the final stage. Most types are held in place by thin plates wedging the liners in place.

The paper gives valuable information as to liner wear and cost, screen and classification data, etc. It has been found that despite its higher cost manganese steel competes economically with white iron in lining. A 12 ft. by 16 ft. primary mill with solid block liners does not retain much gold, but an Osborn bar liner can lock up a considerable amount within and behind the metal and a substantial quantity between the packed pebbles. This calls for special vigilance during relining, which is usually done in two stages, one section being relined and the mill reloaded and restarted within an eight-hour shift. This is done on a Sunday, a special permit being obtained in order to avoid loss of running time. The pebbles at the St. Helena operation were found to be more brittle than those of the older mills. One result of this was the introduction of rod-milling at the primary grinding stage. It has since been found that pebble-milling is possible and cheaper than rod-milling, even with the more fragile pebbles. Where old drill steels can be cut down to form $1\frac{1}{2}$ in. long slugs there is a case for mixed or composite loads of pebbles and such slugs for milling, but there appears to be no justification for using steel balls to increase fineness of grind on the Rand ores at the present price of gold. Pebble consumption is of the order of 200 lb. to 300 lb. per ton of ore milled. It decreases progressively from the first to the third milling stage.

(8) *Thickening.*

Handling Flocculated Pulps

With the special problems of filtration and classification introduced with acid-leach processes new flocculating agents have been marketed and these have necessitated a review of design and operating procedure in the thickening of pulps. Test work based on that of Coe and Clevenger [1] described in 1916 has in consequence been modified. Their observations were based on the zone sequence seen as pulp settled—clarification of the top layer and increased density down to the final stage of compression—*i.e.*, to the *critical point*, below which no further settlement occurred. Thus at any horizon in the transition zone there was a change in pulp density which affected the subsequent settling rate and the critical concentration at that horizon. Their calculation of thickener area was formulated in respect of a transitional rather than a final concentration and within that limitation was dependable. It is :—

$$A = \frac{1{\cdot}33\,(F - D)}{R\Delta}$$

where

A = area (ft.²/ton) of dry solids/24 hours.

$F = \frac{\text{wt. of liquid}}{\text{wt. of solid}}$ in feed.

$D = \frac{\text{wt. of liquid}}{\text{wt. of solid}}$ in discharge.

R = Settling rate (ft./hr.) for pulp at feed concentration.

Δ = Specific gravity of pulp.

In 1952 a new approach was made by Kynch [2] and this has been developed by later workers. The original basic assumption—that the settling velocity of a particle is a function of the local concentration of solids round that particle—is retained. Hence, the transitional changes in the zone of compression are the factors which affect the depth required to obtain data on the critical point. In addition to this zone allowance must be made for a feed-well depth or clarification layer of from 1 ft. to 3 ft. and a storage layer for the fully concentrated slurry of from 1 ft. to 2 ft. There is also an allowance for slope of base toward the central discharge and a 20% factor of safety is customary to allow for irregularities in the feed. Overloading, in the sense that solids arrive faster in the feed than they do in the fully-compressed zone,

[1] "Methods for Determining the Capacities of Slime Settling Tanks," *Trans. A.I.M.E.*, 55, 356.
[2] "A Theory of Sedimentation." *Trans. Faraday Soc.*, 48, 166.

changes the density values through the compression zone and this reduces the falling rate to the discharge zone. It is this effect which is inadequately considered in the original test formula, which is based on settling tests between two levels and not on the concept of a critical end-concentration dependent on mobility through the compression zone.

When the synthetic polyelectrolytes are used as flocculating agents the easily observed zones described by Coe and Clevenger are replaced by a column of pulp with no clear-cut divisions. Such a flocculated pulp settles steadily through transitional stages until fully compressed. This action appears uniform for speed and for all the particles, the coarse ones being adherent to the floccules. Settling is rapid, but the flocculation effects are modified considerably by working conditions in the pulp and standardized techniques are therefore important to the successful use of Kynch's method of determining settling area by means of laboratory tests. This important information is not, of course, the only product of a dependable scheme. The degree of clarification of overflow can be compared for varying conditions (feed rate, depth, concentration, working temperature, dwelling time, and removal rate). So can the qualities of the various polyelectrolytes now marketed so that the economics and the qualities of the underflow can be properly assessed. Such work must be specific to each pulp and tests must be made on pulp in the condition in which it arrives in the thickener.

In the review from which this note is largely abstracted [1] stoppered 500 ml. glass cylinders were used, calibrated in tenths of an inch; 480 ml. of representative pulp were tested, the remaining 20 ml. being reserved for the flocculating agent. This, diluted to 20 ml., was added in three stages, with 15 seconds of gentle mixing between stages. Settling rates, clarity, and appearance of the flocculated solids were then observed at timed intervals under constant-temperature conditions. Settling curves (height against time) were then plotted for unflocculated pulp and for various types and concentrations of reagent. The factors taken into consideration in final choice are set out in the review. The calculation of area requirement by Kynch's method is based on the formula—

$$A = \frac{t_u}{C_o H_o}$$

where

A = unit area in ft.²/ton of solids/24 hours.

t_u = time in days.

C_o = concentration of feed as tons of solid/ft.³ of pulp.

H_o = height in ft.

Since static settlement does not give the true rate of thickening a small rake is used, rotating once a minute in the pulp. The Coe and Clevenger method of determining thickener depth is preferred.

[1] Couche, R. A., and Goldney, L. H. "The Design of Continuous Thickeners for Flocculated Materials." *Trans. Aust. Inst. Min. Metall.*, 191, Sept., 1959, pp. 117–139.

Book Reviews

Industrial Minerals and Rocks. (Nonmetallics other than fuels): A.I.M.E. Seeley W. Mudd Series. Third edition, completely revised. Cloth, large octavo, 934 pages, illustrated. Price 105s. New York: American Institute of Mining, Metallurgical, and Petroleum Engineers.

This third edition (the second was published in 1949) has been completely revised by a distinguished board of editors headed by Joseph L. Gillson, all of whom are leading members of the Industrial Minerals Division of the Society of Mining Engineers of the A.I.M.E. It contains 56 chapters covering all the non-metallics other than fuels, both major and minor—as, for example, abrasives, borax and borates, light-weight aggregates, manganese ore, the sillimanite group, titanium, and so on. Each subject is dealt with in a somewhat standardized manner, usually under such headings as composition and properties, occurrence and sources, uses, preparation for market, mining methods, prices, and other matters of interest. None of the articles is over long and the reviewer was particularly impressed by the way in which a vast amount of information has been assembled in a condensed and readily accessible form without verbosity or unnecessary padding. This book is published, of course, in the United States and it is only to be expected the subjects are dealt with from an American angle. This does not reduce the value of the book, however, as sources and activities outside the United States are dealt with fully where appropriate. Each chapter has an extensive bibliography.

The authors are to be congratulated on an excellent reference book, the publication of which was rendered possible by a grant from the Seeley W. Mudd Memorial Fund.

JAMES RUSSELL.

Outline of Historical Geology. By A. K. WELLS. Fourth edition, revised with the assistance of J. F. KIRKALDY. Cloth, octavo, 398 pages, illustrated. Price 32s. London : Thomas Marby and Co.

This is a difficult book to review, for the value of a book depends on its usefulness to the class for whom it is intended. The author regrets (as indeed does this reviewer) that the " professional geologist has not done all he might do to allow *the man in the street* to share the benefits that arise from his training " (italics by reviewer) and goes on to say that this book is for " the general reader." Elsewhere he refers to it as " a text that would be adequate for university students reading for a Degree in Geology or Geography."

To the reviewer these remarks are incompatible and he cannot believe the earlier presents a true picture of the usefulness of the book. He tends also to quarrel with the title. Why should the post-Precambrian stratigraphy of the British Isles be " Historical " geology, and over 85% of the book is in this category. Basalt, rhyolite, and diorite never reach the index ; granites appear three times. It is true that orogenesis is not excluded and igneous geology receives mention, but should not such a title give them greater balance than appears here ?

Regarded, however, as an " Introduction to Stratigraphy " or a " Simplified Stratigraphy " the book is a delight. Given a modicum of geological knowledge, which neither " the man in the street " nor most " general readers " possess (even at degree level of education) there is a most intriguing approach to the subject and a lucid development of many lines of discussion that are often treated in a dry and involved manner elsewhere.

For whom then is this book intended ? Many geology students must have found it highly valuable as ancillary reading. Many amateurs will have added pleasurably to their knowledge. Above all it seems to the reviewer that there is no work in this field which will approach it in value to the geographer. The title is still regarded as unfair, but one which may have drawn the initial attention of many who subsequently enjoyed the book.

R. A. MACKAY.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Letter to the Editor

Radioactive Minerals in Nyasaland

SIR,—In reply to Professor Davidson's letter in the MAGAZINE for January I regret my acknowledgement made to the U.K. Atomic Energy Authority when it should have been to the Atomic Energy Division of the Geological Survey. Since I left Nyasaland in 1957, however, I have travelled a great deal and have not had ready access to my records. Again, in regard to the betafite crystals it is obvious from the text that what was meant was 2–3 cm. and not 203 cm. As I made no reference to the exceptional size of the crystals in the contribution to *Economic Geology* they were obviously of normal size.

In November, 1956, Mr. C. L. de Jongh removed from a trench that we had dug near Chikoleka Village at Tambane a large oval or bun-shaped boulder of a somewhat porous radioactive and very heavy material. This was broken up for transport to Johannesburg and after breaking up specks of secondary uranium minerals were observed under the ultra-violet lamp. Together with other samples this was sent by road to Salisbury and then by rail to Johannesburg. On arrival in Johannesburg I found that the containers and sample bags had been damaged in transit and that much of the material of some of the samples had been lost and the rest was mixed up. I discarded the samples as I knew that we would be returning in 1957. In 1957 I returned to Tambane and cleared all the trenches and Messrs. G. D. Garlick and C. L. de Jongh early in May, 1957, found a boulder of uraninite with abundant secondary minerals. The first boulder weighed about 140 lb., while the second was at least 50–60 lb. This was broken up, part retained, and the rest sent to Johannesburg for identification. The first identification of uraninite was made in our laboratory at Tambane by Garlick, de

Jongh, and I, and confirmed by Mr. C. F. N. Bawden.

The Atomic Energy Division of the Geological Survey of Great Britain made available to me the following reports :—

Mineralogical Report No.	*Source of Material.*	*Identification.*
561 (5.3.1957)	Dr. V. L. Bosazza *via* Mr. J. H. M. McNaughton.	Allanite-bearing gneiss (R. W. R. Rutland, J. E. T. Horne).
562 (5.3.1957)	*ditto.*	Zircon, metafite, some garnet, no monazite detected (R. W. R. Rutland, J. E. T. Horne).
440 (24.9.1956)	Mr. J. H. M. McNaughton.	Allanite and davidite identified (J. E. T. Horne, K. Taylor, D. Atkin).
537 (4.2.1957)	Mr. J. H. M. McNaughton.	Columbite, monazite, betafite, allanite, davidite (K. J. Ackermann, J. E. T. Horne).

I only received these four reports and it will be noted that uraninite is not included ; in fact the boulder of uraninite (perhaps large nodule might be better) was only discovered after the last report I received from the Division. My laboratory work was done from November, 1956, to March, 1957, so that it is quite correct to say that uraninite was only discovered after the laboratory work was completed. The same applies to brannerite which was discovered in September, 1957, and identified by Mr. C. F. M. Bawden, in the Gold Fields Laboratories.

Dr. Davidson's reference to Ramdohr is not applicable, since I have supported him on this matter in the case of the Witwatersrand bankets.

* * *

In the first part of his article in the February issue Dr. Davidson on p. 89 states "Bosazza (1959) claims to have found uraninite 'both in large boulders of the mineral and in small grains' in the Tambani alluvials of Nyasaland . . ." I have made no claim, whatsoever, but distinctly state that "at Tambane uraninite has been *found in outcrops* with only minor quantities of secondary minerals, both in large boulders and small grains." I did not find any uraninite in the alluvials and in fact made no claim that I had done so. Only betafite was found in the alluvials and the United Kingdom Geological Survey had done that in 1955 as well I think. Geology is essentially a field subject and if there is any doubt of the observations of Tambane, then Dr. Davidson, who has written so much about Nyasaland should visit the area. In one of my trenches, I left two rounded nodules of uraninite *in situ*, about an inch diameter or less to the best of my recollection.

V. L. Bosazza.

Parktown,
Johannesburg.

Feb. 10, Mar. 9, 1960.

Engineering Log

The problem of finding out what has been done in one's own field of research has become almost insuperable in the modern laboratory. It was noted recently that one year's index to "Nuclear Science Abstracts" has 300 pages, weighs 3½ lb., and this is merely an index to the abstracts, not the abstracts themselves! A great deal of pure science progresses by meetings between the workers in a particular field in conferences and visits. This serves reasonably well in university circles but has serious disadvantages when industrial firms are sponsoring research from which they can only benefit if their work is kept secret. The recent duplication of efforts between the General Electric Company of America and the Anglo American Corporation with regard to the making of synthetic diamonds is a case in point. For the research worker there are several first-class sources of information, however, and one of these distributes abstracts of Russian research through the lending library of the D.S.I.R. Attempts are being made to organize the tracking down of information along several lines and a new use of punched cards and magnetic tape is being developed for collating such information. Express services and electronic "thinking" machines are being tested and, if and when something of universal practical value emerges from the thought which is being given to this serious problem, much duplication of effort will be avoided and the lot of the research worker immensely eased.

* * *

The Mattison Machine Works, of Rockford, Illinois, has recently manufactured a tool for grinding and polishing the interior of tubes. The grinding head is mounted at one end of a hollow reciprocating ramrod—in effect a long air cylinder—and the head is expandable. It is pushed through the tubes to be polished by means of compressed air. Grinding is done by the head, using a travelling closed-loop abrasive belt moving inside the tube. To

make the necessary loop the belt is passed through the length of the tube, its two ends glued and spliced under a hot press, uniform grinding of the whole area of the inner surface then being obtained by revolving the tube, setting the abrasive belt in motion, and moving the grinding head back and forth. The machine can deal with almost any seamless or welded material up to 50 ft. long and between $\frac{5}{8}$ in. and 9 in. in diameter. Finish is controlled by varying the grade of abrasive used and speed of ram travel and tube revolution may also be varied. Grinding pressure of the expandable head is controlled by a valve.[1]

* * *

According to a recent Information Circular[2] put out by the United States Bureau of Mines development of the lightweight diesel engine has revolutionized a great deal of placer mining in Alaska. Cumbersome steam-powered shovels and scrapers, once familiar to the Alaskan scene, have given way to diesel-driven bulldozers and draglines that move the gold-bearing gravel to sluice-boxes. Old-fashioned reciprocating and pulsometer pumps have been replaced by portable centrifugal-type units that serve hydraulic giants used for ore-stripping and sluicing. However, despite modernization in the industry operating costs keep mounting and labour is increasingly difficult to obtain. Nevertheless, the placer mines consistently achieve a combined gold output valued at well over a million dollars a year and to do this most placer mines operate on 9- to 10-hour shifts seven days a week during their short working season. Fourteen typical placer mines are described in detail in the Bureau's illustrated report.

* * *

The synthetic industrial diamond grit now in commercial production to the extent of 3,500,000 carats annually competes with the natural product at its market price of 21s. per carat. African producers have met this challenge with confidence and are prepared to compete in synthetic production, although an improved grade of the natural stones used in resin-bonded abrasive wheels (an 8,000,000 carats *per annum* market) should make this unnecessary. The General Electric Co. of America synthesis uses a critical combination of pressure and temperature aided by the catalytic action of nickel. X-ray comparison suggests similarity of structure save that the artificial product contains small inclusions of nickel. They are crystallites and readily disintegrate. This at present excludes them from use in metal and ceramic bonds, which absorb the bulk of the output (58,500,000 carats during the first nine months of 1959). In resin-bonded wheels their brittleness is helpful, as only light grinding is performed, and fracture produces fresh sharp edges. De Beers have met this point by subjecting their natural stones to special treatment for the resin-bonded market.

* * *

Metallurgists now seem able to produce special alloys too tough to be machined by standard methods. The answer has been found in chemical dissolution of the unwanted part of the casting. A protective coating is applied and removed where required. The unprotected parts are then etched away. Tolerances of the order of 0·002 in. are possible and the restrictions as to shaping and cutting inevitable in lathe and plane work do not exist. Forty North American companies are now licensees and 1959 sales in this rapidly expanding market were $5,000,000. Guided missiles and aircraft components provide the present outlets.

Black Lake Quebec

After nearly five years of continuous operation, having worked its way down more than 560 ft. below the original level of Black Lake, Quebec, the $2,700,000 dredge "Fleur de Lis" has been put up on stilts on the former lake bottom. What was once a 500-acre lake is now an open-pit asbestos mine, capable of producing 100,000 tons of fibre annually. The mine, and adjacent mill, are operated by Lake Asbestos of Quebec, Ltd., a wholly owned subsidiary of the American Smelting and Refining Company.

During its more than 51 months of continuous operation the "Fleur de Lis" pumped a total of more than 75,000,000,000 gal. of water at a rate of 45,000 gal. per min. In addition the dredge removed over 31,029,000 cu. ft. of silt and overburden to uncover the deposit. Operations were continued the year-round, with two tugs serving

[1] *Comp. Air Mag.*, Dec., 1959.

[2] THOMAS, B. I., and KERNS, W. H. *Inf. Circ. U.S. Bur. Min.*, 7926.

Dredge at Rest in the Open-Pit.

as icebreakers during the harsh Quebec winters to keep the project moving on schedule. The mine began producing in October, 1958, with the dredge still pumping out the lake bottom. Asarco is to keep the "Fleur de Lis" temporarily at Black Lake on a standby basis.

News Letters

BRITISH COLUMBIA

March 12.

Portland Canal.—Mr. Thomas McQuillan, the veteran prospector and miner, who with a few associates conducted a very successful salvage operation on property leased from Silbak Premier Mines, Ltd., in the autumn of 1959, is to return and commence mining as soon as snow can be cleared from Stewart to the mine. In the brief period from September 15 when the one-year lease was obtained McQuillan and his crew, until driven out by deep snow, mined, cobbed, and shipped 62 tons of high-grade ore. The first 50 tons assayed 11·85 oz. of gold and 299 oz. of silver per ton, with 15% in combined lead and zinc, and brought net returns of $594 per ton to the lessees. The remaining 12 tons was of lower-grade material, netting only $257·60 per ton.

Skeena.—Western Surf Inlet Mines, Ltd., successor to companies with a long record of profitable gold production from the Surf and Pugsley mines on Princess Royal Island, has acquired an option to purchase a group of mineral claims in the Noranda area of Quebec. The company, in addition to its gold property, holds a 40% interest in the issued shares of Sunset Yellowknife Mines, Ltd., owner of a promising gold prospect, and 59% of the shares of the McVicar Mining Co., Ltd., whose 22-claim base-metal group adjoins the Britannia mine, near Vancouver.

Vancouver.—The president of Taiga Mines, Ltd., has advised shareholders that discussions are continuing as to the most efficient arrangement for developing the company's germanium deposit near Powell River. Several Canadian and American mining companies, as well as Japanese interests, have sent engineers to examine the property and take samples for metallurgical tests. Although the results of this work have varied widely, the Taiga management is convinced an economic orebody exists and is worthy of further development. Investigation of the market for the metal indicates a strong demand.

Alberni.—The Big Interior Prospecting Syndicate is to continue drilling its copper prospect high on a plateau 10 miles north of Great Central Lake, Vancouver Island. Despite the difficult location, necessitating all servicing by helicopter, considerable work was accomplished during 1959. The Syndicate is headed by Andrew Robertson of Toronto and associated in the venture are Tombac Explorations, Ltd., the Lambton Copper Co., Ltd., Americanadian Mining and Exploration, Ltd., and Colville Explorers, Ltd.

Tanar Gold Mines Ltd. has purchased the You group of four Crown-granted claims on the south-west flank of Big Interior Mountain. Outcrops were found last year at the 2,500-ft. horizon above an adit driven by former operators. It is proposed to invoke the use of hydraulic stripping and to open a new exploratory tunnel 200 ft. below the existing adit.

Nicola.—The suit of Mr. J. A. Stinson, prospector, and the Contact Mining and Development Co., Ltd., against Craigmont Mines, Ltd., seeking to establish

that the staking of Craigmont's key claims was invalid, was dismissed on March 3 in the British Columbia Supreme Court. The ruling is regarded as extremely important as an interpretation of the Province's mining laws. The separate suits of Stinson and the Contact company were consolidated for the hearing, which occupied 26 days in court.

Highland Valley.—Tentative agreement has been reached by the directors of the Bethlehem Copper Corporation and technical representatives of the Sumitomo Group, of Tokyo, for financing to production of the former's copper property and the proposal has been presented to the Japanese Government for approval. Mr. H. H. Huestis, the Bethlehem president, anticipates production by the autumn of 1962 at an initial rate of 3,000 tons a day, a figure, he says, to be increased to 5,000 tons within two years after commencement. The company's consulting engineers had recommended daily treatment of 7,500 tons of ore as the most efficient rate. The decision to commence at the lower rate was made, Mr. Huestis states, "because money is tight and because we intend to start milling the higher-grade ore of the East Jersey zone, thus permitting us to take advantage of maximum profit during the tax-free period."

Rio Tinto Canadian Exploration, since taking over the exploration by agreement last year, has carried out geological and geochemical surveys and completed an induced-polarization survey covering 10½ miles of the Highland Valley property of Trojan Consolidated Mines, Ltd. Two anomalies of interest have been indicated. The work has been done in the same area in which 500,000 tons of ore grading 2·01% copper were indicated by underground development in 1957 and extends northerly therefrom. If Riocanex pursues the project to production Trojan is to receive a return of $750,000 to cover the cost of work performed *plus* a 20% interest in profits.

Greenwood.—In the first two months following settlement of the labour strike at the Tacoma smelter Consolidated Woodgreen Mines has shipped 1,180 tons of copper-gold-silver concentrate with a net value of U.S. $187,764. All advances by American Smelting and Refining Co. during the period of idleness at the smelter have been repaid. In the nine-month period to the end of 1959 Consolidated Woodgreen spent $123,389 on plant and equipment, $81,771 on mine development, and $63,000 on housing.

Sheritt Lee Mines, Ltd., has been converted into a public company in order to obtain financing to develop its silver prospects, the principal of which is the Silver Bounty mine at Beaverdell. A small crew of men is at work at the mine making test shipments of ore. The company hopes to drive a new exploratory tunnel at the 2,600-ft. elevation. The properties adjoin the highly successful Highland-Bell mine.

Nelson.—Shareholders of Placer Development, Ltd., have been advised in the latest quarterly report that the wholly-owned subsidiary, Canadian Exploration, Ltd., produced 9,897 tons of lead-zinc concentrates from its Salmo properties in the three-month period ended January 31, 1960. Recovery was made from 95,803 tons of ore grading 3·01% lead and 4·33% zinc. Including the quarter cumulative production for the first nine months of the current fiscal year is 24,914 (28,466) tons of concentrate from 253,640 (286,310) tons of ore assaying 2·70% (2·83%) lead and 4·22% (4·37%) zinc. The estimated gross operating profit for the period was $699,931 ($885,600). After exploration expenditure of $140,614 ($124,800) and provision for depreciation of $271,350 ($400,000) the estimated net profit for the period was $287,967. Figures in parentheses cover the comparable nine-month period of the previous fiscal year, in which a further deduction of $113,700 for Federal and Provincial taxes resulted in a net operating profit of $247,100. Canadian Exploration is sharing equally with Noranda Mines, Ltd., and McIntyre Porcupine Mines, Ltd., in the development of the Watson Lake (Quebec) property of Mattagami Lake Mines, Ltd. The operating group has exercised its option to take up shares in the Mattagami Lake company and has elected six of its nine directors. Interim financing has been arranged and plans have been made for further development, including engineering studies of mine, plant, and smelter.

The copper-iron property of Craigmont Mines, Ltd., at Merritt, continues to develop satisfactorily under the direction of the operating group, consisting of Canadian Exploration, Noranda Mines, and Peerless Oil and Gas. This property is generally conceded to be very near the production-announcement stage, although the Placer Development report makes no mention of that.

American Exploration and Mining, another Placer subsidiary, continued the investigation of properties in Arizona, California, Montana, Nevada, New Mexico, and the Philippines during the quarter. Surface sampling continued at the open-pit gold property in Montana and drilling and sampling were completed on a copper property in New Mexico; reserves were found to be insufficient to permit a profitable operation. In the Philippines a new geological report and map have been prepared of the area of general interest at the Marinduque Island potential open-pit copper property. In Alaska the Evan Jones Coal Co., in which American Exploration and Mining holds a 48⅓% interest, continued to operate at a satisfactory profit.

In North Queensland work at the Gilmore tin mine was confined mainly to shaft-sinking, testing of small higher-grade ore pipes, and diamond drilling.

Yukon.—Conwest Exploration has sold its 625,000 shares of United Keno Hill Mines to its former partner, Ventures, Ltd., for a price of $3,750,000. Although no changes in operating personnel are contemplated at present it is the intention of Ventures to assume management gradually. The Keno Hill properties were purchased in 1945 from the Treadwell Yukon Corporation and although Frobisher and Ventures supplied 51% of the purchase funds management was vested in Conwest. The big Yukon mine is Canada's leading silver producer, with current production in excess of 7,000,000 oz. annually.

New Zealand.—The Waikino gold property of South Pacific Mines, Ltd., a British Columbia company, is now in production. The small reclaimed mill is at present treating some 50 tons of tailing and gold-impregnated soil at the formerly producing Martha mine. A recent shipment of 25 tons of concentrate was shipped to Australia with the remarkable grade of 50 oz. of gold and 50 oz. of silver per ton. The company proposes to erect a 300-ton concentrator on the property, after which it will also treat the lower-grade Ohinemuri River sands. Mr. Alfred R. Allen, formerly of Vancouver, is directing South Pacific's New Zealand operations and has recently added two geologists to his staff.

EASTERN CANADA

March 20.

Ontario Gold Output.—Returns from the producing gold mines of Ontario for January show that 226,856 oz. of gold and 27,617 oz. of silver, valued at $7,550,068, were produced from 778,103 tons of ore milled.

Sudbury Mining Division.—The Ontario Department of Mines has announced the release of uncoloured geological maps of the townships of Rayside, Lumsden, Dowling, Hanmer, Balfour and the northern part of Fairbank, on a scale of ¼-mile to 1 in. These were compiled for use in the preparation of Map 1956–1 (Sudbury Basin Area), but have not been previously released. The geological information on these sheets is very similar to that on Map 1956–1, but on a larger scale. Uncoloured white prints can be obtained on order from the Department of Mines, where coloured copies are available for inspection.

Porcupine.—It is expected that copper production from the Kam-Kotia copper-zinc property of Violamac Mines will start later this year. A flotation plant is being erected. Recent work has disclosed what appears to be a third ore-body at depth. For the first few years open-pit mining is expected to provide 1,000 tons of ore daily to the mill.

Sudbury.—The report of the International Nickel Co. of Canada for 1959 shows that earnings for the company and its subsidiaries were $85,157,000 in U.S. currency, equal to $5·83 per common share, as compared with $39,665,000, or $2·71 per share in 1958 and $86,141,000, or $5·90 per share in 1957. In the year the company delivered a record 317,040,000 lb. of nickel, the 1959 recovery in demand reflecting " industry's renewed confidence in a plentiful nickel supply, the market development efforts of the company, and a world-wide rise in business activity." Copper deliveries were 252,450,000 lb., as compared with 210,570,000 lb. in 1958 and with the post-war record of 280,810,000 lb. in 1957. Deliveries of platinum metals—platinum, palladium, rhodium, ruthenium, and iridium—were 384,600 oz. in 1959, as compared with the post-war low of 145,400 oz. in 1958 and with 339,400 oz. in 1957. Iron ore deliveries of 162,000 long tons were more than 30% above those of the preceding year. The report states that the new nickel project at Thompson, Manitoba, which will add 75,000,000 lb. of nickel per year to the company's production capacity, was brought closer to completion in 1959, while construction of the Kelsey power station of the Manitoba Hydro-Electric Board proceeded satisfactorily. The first power from Kelsey has been scheduled by the Board for delivery to International Nickel in June, with full production in early 1961. The proved ore reserves at Sudbury stood at 264,864,000 short tons at December 31, 1959, as compared with 264,628,000 short tons at the end of the previous year.

The company's exploration expenditures in 1959 amounted to $7,989,000, the Manitoba exploration continuing to account for about one-half of the total. In the Sudbury District the systematic investigation, both surface and underground, of favourable geological locations and extensions of ore zones has been continued with satisfactory results, while the examination of nickel occurrences and the exploration of ore possibilities were also carried out in Northern Ontario, Saskatchewan, and the Northwest Territories of Canada, and in Africa, Australia, New Caledonia, and the United States.

Manitouwadge.—Shareholders of Geco Mines have been informed that during 1959 the mill treated 1,290,279 tons of ore, operations resulting in a profit of $6,146,000. During the year the Mining Corporation of Canada, Ltd. loan was reduced by $5,520,000, leaving $4,080,000 still owing at December 31, 1959. (This has since been reduced to $3,240,000.) No. 3 shaft was bottomed at 2,565 ft. in December and development from this opening commenced in January of this year. Capital additions during the year included $842,045 for plant buildings and equipment, $579,140 for employee housing, and $685,261 for shaft sinking and other capital development.

Quebec.—During 1959 the Quemont Mining Corporation milled 850,099 tons of ore and made a profit of $2,073,000, equal to 99 cents a share.

SOUTHERN AFRICA

March 23.

Budget.—In the 1958–59 year the gross national income increased by about £41,000,000 to £2,027,000,000 of which £1,798,300,000 (about 2·5% higher) was attributed to domestic sources and the balance to external holders of interests in the country. However, the net income *per capita* showed a slight decline. This, as well as the general economic and financial conditions, probably influenced the Minister of Finance in his Budget towards lightening the burden in some directions. Earlier he had announced that in the spirit of the times Exchange Control may be revised and, where possible, relaxed. However, South Africa, as a capital-importing country, cannot afford to lift that control altogether. Nevertheless, he had decided to remove from control the transfer of funds from the Union for investment in the Central African Federation, except in fixed-interest securities and deposits. Increased allowances for South Africans travelling abroad were also permitted. In his Budget address the Minister commented that to break the circle of a dampened tempo of economic activity, reduced turnovers and profits, and reluctance on the part of manufacturers and investors to risk further capital outlay, and postponement of development plans, stimulation of the economy was required to provide for a growing population. An investment allowance was therefore granted manufacturers, deductable from taxable incomes, in respect of new buildings and plant installed; all public companies were exempted from the undistributed profits tax; private companies controlled in the Union but with external shareholders were exempted from the non-resident shareholders' tax, which, where still applicable, became applied to net income after taxation instead of gross income. In other words, encouragement was given to the formation of public companies and the vesting of control in South African companies or companies registered in South Africa. The methods of taxing individuals were revised and simplified, with an average relief of about 5% and relief for a portion of income derived from dividends and super-tax abolished. This taxation

was to be based on group basic rates, increasing in each group according to a sliding scale. In an appeal to industry to assist the universities donations by companies up to 1% of taxable income would be tax-free, to stimulate research and development. The method of taxing processed-film distribution was revised on the basis of revenue earned. In addition to these and other concessions the loan levy was abolished and the issue of Treasury bonds discontinued. The total value of the concessions on the basis of 1959–60 taxation is about £21,000,000. Factors making the concessions possible were reduced imports and increased exports and in particular the increasing contributions of gold mining to Treasury receipts and earnings of exchange. The new gold mines and the gold-uranium producers, which had enjoyed freedom relatively or completely from taxation by reason of low earnings and capital expenditure amortization, were now becoming increasingly liable to taxation. While still disinflationary, the Budget proposed to lighten the burden to this extent—that, whereas in 1959–60 revenue provided nearly £50,000,000 for the loan account, in 1960–61 this appropriation from revenue would be reduced to £18,500,000 *plus* any surplus on revenue account. If circumstances permit further relief would be granted next year.

Railways.—South African Railways entered its centenary year with a working surplus of £1,907,000, the 1959–60 revenue being estimated at £198,273,000 and estimated expenditure at £196,366,000. An important factor in this surplus was the co-operation of the staff at all levels in the programme of greater efficiencies and economies maintained at an intensified pitch. In his Railways Budget address the Minister of Transport stated that, in the year, traffic generally moved freely and that the stage has been reached where all traffic offering can be handled. Nevertheless, the programme of railway expansion is still being pressed forward to secure efficient working and also to provide for further traffic growth. Over the first ten months of 1959–60, average tractive effort available increased by about 3%, while goods vehicles increased by 5·2%. With the economic recovery expected to be gradual an excess of carrying capacity will continue for some time. Over the first 7 months of 1959–60 increased ore traffic compensated somewhat for net decreases elsewhere—particularly agricultural products and the high-rated import traffic. Higher tonnages of iron ore, chromite, and manganese ore, were carried, as in the case of coal where, however, ton-miles declined by 1·7% due to the short-distance haul. With road transport of coal suspended from the beginning of 1960 the coal tonnages can be expected to increase further in the closing months of the year.

Despite continued resignations of a high though reduced order the staff position showed a further improvement; certain categories, however, reflected shortfalls, especially in various operating classifications. Training of and educational facilities for personnel were broadened. Combined with the new works programme is the modernization project, with improved procedures and working conditions.

Traffic expectations for 1960–61 are brighter, on the grounds of greater gold production, stronger demands for iron and manganese ores, and increases in other export items, as well as increased revenue from coal traffic.

Institute of Directors.—The only level of administration in the public company structure of South Africa not formally organized has been that of directors. This deficiency has now been remedied by the formation of the Institute of Directors, affiliated to the parent organization of the United Kingdom. Under the chairmanship of Mr. H. Entwistle, a committee was recently formed representative of mining, industry, commerce, and publishing. Mr. Entwistle is an executive of a company in the Anglo American group.

Transvaal.—Western Deep Levels, in the main vertical hoisting component of the No. 2 twin-shaft system, has intersected the Ventersdorp Contact Reef at a depth of 5,599 ft. below the collar. Faulting limited full reef exposure to about 89% of the perimeter of 90 ft., the full exposure averaging 7·59 dwt. over a channel width of 41·5 in. or 315 in.-dwt. This average more or less conforms to what has been expected as the approximate average for the horizon, especially in the sub-outcrop zone, but wide fluctuations may be expected. While the depth of the sub-outcrop along its strike north-eastwards to south-westwards appears to increase relatively slightly and gradually, the dip of the reef at 28° is marked and, with the width, indicates a high tonnage per claim. Limited drilling in the lease area indicated an average range for the Ventersdorp Contact of about 250 in.-dwt. to 300 in.-dwt., with wide fluctuations to be expected. Development on the horizon has so far been confined to footages advanced from the haulages driven from the neighbouring West Driefontein mine. The limited footage sampled, 555 ft., has averaged 97 in.-dwt., of which 45 ft. payable averaged 375·8 in.-dwt. Development in sub-outcrop zones often discloses erratic mineralization and values. It is therefore possible that with the extension of operations, especially at depth from the sub-outcrop, payability and values may improve.

Shaft-sinking operations have been advanced well ahead of schedule and capital already provided has been rapidly utilized. These conditions have brought about a re-organization of the development programme and necessitated the raising of an additional £14,500,000 by a share issue to cover operations to the third 1962 quarter. This will include all or most of the programme to complete the vertical components of both shaft systems, initiating milling of about 80,000 tons a month of Ventersdorp Contact ore, sinking the sub-vertical components to open up the Carbon Leader Reef, and milling about 40,000 tons a month of this much higher grade ore. The next stage will see the milling rate built up to a projected 200,000 tons to 240,000 tons a month range, mostly with ore from the Carbon Leader horizon. All the vertical components will be sunk to about 6,300 ft.; the sub-vertical components to a depth of 9,700 ft. Both No. 3 vertical components have been completed to their final depths; the No. 2 units are approaching their final stages.

Drilling has been completed by Hartebeestfontein Gold Mining Co., Ltd., in the most southerly of the boreholes in the western section. In that borehole, near the site of the projected No. 4 Shaft, two deflections have disclosed 239 in.-dwt. and 275 in.-dwt. at 6,730/1 ft., against 316 in.-dwt. in the original. Drilling results from the third borehole are awaited, while in the second borehole 714 in.-dwt., 602 in.-dwt., and 15,317 in.-dwt. were obtained. Including the latter high values, which may be due to fault enrichment, the indicated borehole grade range becomes 720 in.-dwt. to 1,550 in.-dwt. over 38·8 in., but excluding the highest, 15,317 in.-dwt.,

the range is assessed as 245 in.-dwt. to 385 in.-dwt. over 38·8 in. The No. 4 Shaft, 24 ft. lined diameter, will be sunk to about 7,500 ft.

Interest is now being evinced in what may be described as the second line of gold occurrences south of and more or less parallel of the Witwatersrand proper, especially in the Lawley area, to the east of Western Areas mine. In this second line faulting may have upcast the Upper Witwatersrand system to economic depths, particularly in places.

Johannesburg Consolidated Investment has acquired a substantial shareholding in the African Asbestos-Cement Corporation and is now administering the company. The latter recently initiated a development programme in its Kalkloof chrysotile property to establish reserves in new zones and has probably by now commissioned its recently-erected grading plant. The company also has the controlling interest in Barberton Iron and Steel (Pty.), Ltd.

Orange Free State.—The Riebeeck shaft, No. 3, of Loraine Gold Mines has been completed to its final depth of about 5,850 ft., near the base of which the lower of the two Kimberley Reefs, the *B*, occurs. The *A* Reef was intersected at 5,496 ft. with values of 386 in.-dwt. over 115 in. As was expected the multi-banded Elsburg Reefs were not intersected in the shaft with payable values. Following equipping and other work in the shaft, a connexion from the shaft with the nearest twin-haulage driven from the northern Loraine section will be cut, to be followed by raising to a haulage on a higher level. This will provide sufficient faces in the multi-banded Elsburg Reefs zone to enable stoping to be initiated early next year, if not before. The Elsburg Reefs are in a syncline with a steeply-dipping western limb and lie unconformably below a boulder bed or reef, near which there are some indications of a marked increase in Elsburg values and which itself carries erratic values in zones probably often of a high order. The boulder horizon is doubtless massive. Owing to the geology of the Elsburg Reefs an accurate assessment of the average borehole grade cannot be given, but an indicated grade range is about 500 in.-dwt. to 800 in.-dwt. over, say, 46 in. This will be diluted in operations and by admixture with lower-grade Basal Reef from the Loraine section. In addition to the Riebeeck, No. 3, shaft, another shaft will be required at some future time, depending on progress in the mine. While the present milling capacity is about 80,000 tons to 96,000 tons a month the mine's hoisting capacity will be about 160,000 tons a month of ore to mill, including the Riebeeck Shaft.

AUSTRALIA

March 21.

Coal.—Two of the largest coal-mining companies in Australia plan to merge and form a holding company. They are J. and A. Brown Abermain Seaham Collieries, Ltd., and Caledonian Collieries, Ltd., which share with the Broken Hill Proprietary Co., Ltd., the leadership of the black-coal mining industry in New South Wales. The merger will be most important for the industry and considerable benefit is expected to result, the mines of both companies being highly mechanized and their efficiency high. The merged companies will be better able to compete with oil. Caledonian Collieries has a substantial export market, which J. and A. Brown lack, but have no colliers, while J. and A. Brown have a large fleet. The merged companies will be the largest organization of its kind in the Commonwealth. The general trend of industrial affairs, in coal particularly, renders amalgamations of operating companies essential to existence, progress, and a competition with outside interests where costs are all-important. There should be considerable improvement in the industry, more satisfactory mining of the large coal-bearing areas of the State, lower working costs, and better disposal of the product.

Iron Ore.—The great increase in Australian demand for steel is such that the heavy expansion and capital expenditure of The Broken Hill Proprietary Co., Ltd., fails to keep pace with the country's requirements. The company has wide expansion in progress in Western Australia, South Australia, and at its steelworks in New South Wales. The search for iron-ore deposits has been very active and has been supplemented by exploration by the Western Australian Government and the Government of South Australia. The latter State has authorized a low-level aerial survey to search for iron ore, which it is hoped will locate targets for diamond drilling in an area of 326 sq. miles in which magnetic indications were recorded in a previous high-level survey. The most promising fields for investigation are in South Australia, Western Australia, and North Queensland.

Peko Copper.—This interesting Northern Territory copper mine is handicapped by handling problems, the cost of transport from the mine to smelters on the New South Wales coast being equivalent to £100 per ton of copper. The company has contracted with Japanese smelters for the delivery of 30,000 tons of copper concentrates per year, but shipment from Darwin is unattractive. The Queensland Government is understood to have put forward a transport proposition from Mount Isa to Townsville, the Peko company to deliver concentrate by road, 400 miles from the mine, to Mount Isa. The problem is to acquire additional interest through the development of the company's Orlando lease, 8 miles distant, in which attractive copper values over substantial widths have been disclosed at a depth below 400 ft.

The Tennant Creek field is attracting increased interest following the Peko company's developments in its Orlando lease and it is possible that prospecting for copper in abandoned leases may be resumed below the limits of the gold occurrences. The rich Noble's Nob mine of Australian Development, N.L., continues steady production. Hitherto payable gold has not been proved below 315 ft., but a discovery has been made at 370 ft., where an east drive has advanced 26 ft. in haematitic chlorite schist in reported high values. A cross-cut on that level has cut 9 ft. of ore assaying 40 dwt. gold per ton.

At the northern end of the field a company has started diamond drilling on an abandoned lease on which are prominent haematite outcrops. The haematite on the field is not auriferous, but gold deposits in its vicinity are characteristic.

Zinc.—For several years research has been directed to the recovery of zinc from the extensive slag dumps at the Broken Hill Associated Smelters at Port Pirie, which have resulted from the smelting of lead concentrates from the Broken Hill mines. It has now been announced that treatment of the

dump is to be undertaken, using a new type of blast-furnace. This furnace and ancillary plant are expected to cost £A2,500,000 and the coke works cost is estimated at £750,000. To supply water for the new enterprise the pipe-line from the Murray River to Whyalla is to be duplicated. Completion of the coke works is looked for by the end of 1961 and production from the zinc smelter two years later. Coal can be obtained from the South Coast Collieries in New South Wales.

Oil Search.—The search for oil is being pressed on. In Papua Australasian Petroleum Co. Pty. has started drilling its Iehi well, which is to be financed by an issue of 1,600,000 shares of £1 each. These will be taken up by British Petroleum and Oil Search, Ltd. A partner (Vacuum Oil Co.) in the groups' existing operations will not participate because of the nature of the commitments now carried. Oil Search will have subscribed £A4,800,000 to the search up to date.

Radioactive Ore in New Zealand.—For some time there has been active prospecting for radioactive mineral in the Buller Gorge country. Cumulative results have been such as to warrant larger-scale exploration and sand drilling and other equipment has been flown into the locality recently. There is little information as to the nature and grade of the discoveries, but activity has been followed by a report of the discovery stated to be of the richest radioactive mineral in New Zealand outside the Buller Gorge. The new find is in the Pororari River Valley, on the west coast of the South Island, between Greymouth and Westport.

Aluminium.—The Weipa bauxite deposits have been authoritatively stated to be large enough to keep a very large power plant in operation. Comalco, the company developing the deposits, is giving much attention to the power resources that may be developed for the undertaking. Three are being investigated. In New Guinea an important source of power is the Purari River, on which are two good dam sites and a potential of 800,000 kW. for transmission to a bauxite processing and smelting plant on the coast of Papua. On the Australian mainland the large coal seam at Blair Athol in central Queensland is a prospective source of thermal-generated electricity; it offers open-cut mining on a large scale, but is some 230 miles from the coast where the works would no doubt be established. In New Zealand the power possibilities of Lakes Nanapouri and Te Anau are being investigated. It is stated, however, that New Zealand electric power is not an alternative, but complementary to the sources of power under consideration in Australia.

The future of the Bell Bay aluminium works, in Tasmania, is a matter for interest. Expansion from an output capacity of 12,000 tons to 16,000 tons per year has been decided on as an essential in the development of the enterprise, but the problem is finance. The works are owned jointly by the Commonwealth and Tasmanian State Governments and the former is unwilling to put more money into the enterprise, while the State is limited in the extent of a future commitment. Negotiations have, therefore, been in progress for the admittance of private enterprise into partnership, an arrangement which could permit much greater expansion. It is now reported that a large aluminium company is discussing the project with the Commonwealth Government with the object of purchase and the move is regarded as a possible first step in the treatment of Weipa bauxite in Tasmania.

At present the Bell Bay works is using Indonesian bauxite, but with the provision of harbour works at Weipa, which are in the planning stage, Weipa bauxite could be shipped to Bell Bay. Investigations into the technical and economic aspects of Bell Bay have been in progress for some time and British Aluminium is reported to hold an option over the plant. The works commenced operations in 1955 and cost £A11,200,000. It is stated that the plant would require modification to treat Weipa ore which differs from other ore. Comalco is planning the production of 250,000 tons of finished aluminium per year and is committed to converting bauxite to alumina at Weipa, in Queensland. Expenditure at Weipa is visualized to the extent of £A45,000,000, which includes expenditure on a harbour and town of £A4,000,000. Comalco is owned jointly by Consolidated Zinc Pty., Ltd., and the British Aluminium Co. Ltd.

Broken Hill Proprietary.—The company's steel centres at Newcastle and Port Kembla, New South Wales, are now producing steel at the rate of 3,500,000 ingot tons per year. Expenditure on expansion in the last half year was £A13,000,000. At Port Kembla construction is to be started on a new open-hearth furnace with a capacity of 300,000 tons of steel per year. It has been decided to install an oxygen steel-making plant at Whyalla, South Australia, and also intended to produce leaded steel, which has not hitherto been made in Australia.

A general increase in the price for steel was made in January by Broken Hill Proprietary, this being the first increase in price since 1956, despite steady increases in the cost of labour and stores. In view of the rapid rise in wages, consequent upon Arbitration Court Awards, and their far-reaching influence on all services, an increase in the price of steel has been expected. Despite the very heavy rises in the cost of wages, services, and materials, increased productivity over the succeeding period has enabled higher selling prices to be avoided, but industrial events in the closing months of 1959 have made the increase inevitable.

Mount Isa.—Mount Isa Mines continues to increase production at a steady rate. The company has entered into a large contract with Japanese smelters for the purchase of copper concentrates, but whether these arrangements extend beyond the completion of the new enlarged smelter at the mine and extensions to the Townsville refinery is not known.

Hill 50 Gold Mine.—This mine shares with the Norseman Gold Corporation the position of being the richest mine in Western Australia, but development of lower-grade ore below 1,100 ft. has caused a marked fall in the grade of milling ore, to compensate for which mill capacity has been increased. Development results have continued to be discouraging, but latterly there has been improvement, with the location of payable ore at, and below, the 1,632-ft. level, where several sections of good lode have been disclosed. Values have ranged from 6·3 dwt. to 10 dwt. gold per ton and drilling is in progress to determine the downward continuation. Sinking of the main shaft has been in progress and the total depth is now 1,902 ft.

The success of Hill 50 in locating a good gold-bearing zone below the lean zone to about 700 ft. has led to a boom in the Mount Magnet field and the formation of several companies to prospect abandoned areas and mines.

FAR EAST

March 8.

Malayan Tin Industry.—For the second quarter Malaya's share of permitted tin exports goes up to 14,156 tons. This follows the International Tin Council's decision to increase permitted exports of the six producer countries belonging to the International Tin Agreement from 36,000 tons to 37,500 tons. Now the position is that Malaya's share for the new quarter amounts to more than 95% of the average total production in the days before restriction was imposed. However, since restriction caused many mines to be closed output will not necessarily increase in proportion and countries which have difficulty in increasing their production sufficiently but have high stocks will be able to start disposal at a moderate rate.

In Malaya Mr. P. A. Delme-Radcliffe, president of the F.M.S. Chamber of Mines, giving his personal views, said : " It might be premature to raise the permissible export again because too high a figure would tend to depress the price of tin. . . . The increase is a small one and will not make a great deal of difference. I doubt if it will encourage miners whose mines are still closed to restart so long as the new oil tax is in existence."

Mines are included among large consumers who will have to pay more for their electricity in Malaya. This move will enable the Central Electricity Board to recover a large proportion of increased costs caused by the new tax on fuel oils.

Mr. J. N. McHugh, managing director of the Rompin Mining Company, said in Kuala Lumpur that the first order for equipment for building a 55-mile railway for a new iron-ore mine in Malaya had been ordered from the U.S.A. The railway will extend from the mine to the coast, where the ore will be shipped to Japan. Mr. McHugh, who recently returned to Malaya from talks in Washington with Export Import Bank officials, said the equipment consisted of heavy construction machines which should be in operation at the coastal end of the railway route by mid-April. Preparatory work is now in progress at the Rantau Panjang site, on the east coast at the mouth of the Rompin River, where the port facilities for shipping the ore would be situated. It is hoped that 25 miles of railway would be laid this year.

The Rompin development is to continue to draw on the technical and professional assistance of Eastern Mining and Metals. The experience gained by that company in the Dungun project was a major factor which made the Rompin venture possible. Some 1,000,000 tons of ore are expected to be produced from the latter venture in 1962 and 2,000,000 tons a year thereafter.

A special committee has been set up by the Pahang State Government to consider the replanning and development of Kuala Rompin, a small fishing port bordering the proposed coastal terminus.

Local government approval has now been given for private companies to operate iron ore mines in several areas of the Cha'ah district of Johore, Federation of Malaya. The prospective mines are situated south of Gunong Ma'akil. The companies concerned have made tentative plans to build an eight-mile road from Gunong Ma'akil to Yong Peng to transport the ore. The Sri Menanti Iron Mining Company at Batu Pahat has already acquired about 500 acres of land at Sungei Sayong—five miles south of Gunong Ma'akil—for iron ore mining. Roads and quarters for staff are being constructed in the area.

Aluminium Products for Malaya.—China Engineers, Ltd., of Singapore, has arranged to fabricate American aluminium products in Singapore and the Federation of Malaya. The company has been appointed agent in Singapore and the Federation for Alukon International, Ltd., and the latter's associated group of American architectural aluminium manufacturers. It will act as stockists, fabricators and installation engineers, and provide complete technical, design, and estimating services.

Sarawak Gold Production.—Gold production in Sarawak, Borneo, totalled 2,400 fine oz. last year nearly three times the output of the previous year. The gold is located at Bau, 25 miles south-west of Kuching and nine mines were in operation. To help the producers the royalty on gold was waived a few years ago, but the biggest help was given in late 1958 when, after long effort, permission was obtained to allow gold to be sold on the free market. The increase in production last year is largely the result of the change in the regulations and most Bau gold is now being so'd locally in Kuching. Dr. F. W. Roe, Director of the Geological Survey has said that he doubted if the industry could regain its former importance. He said last year's increase clearly showed that, given a reasonable price, a useful gold output could still be obtained from the isolated scattered and generally small but relatively rich deposits.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Track-Mounted Drilling Machine

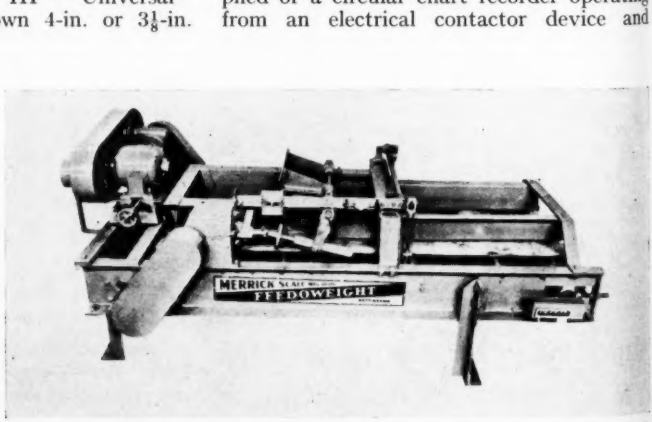
A new track-mounted machine is announced by **Halifax Tool Co., Ltd.**, of West Lane, Southowram, Halifax, manufacturers of Halco-Stenuick rock-drilling machines.

Track-Mounted Drill.

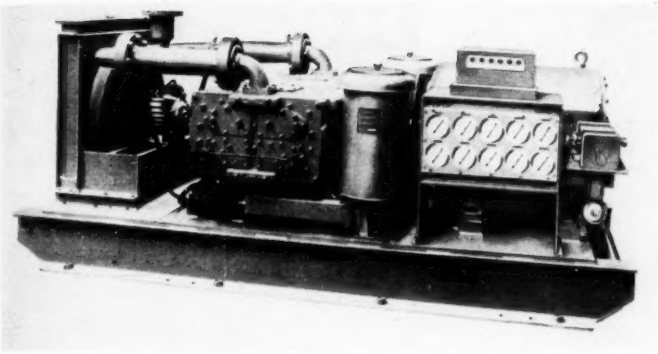
The tracks are driven by independent air motors. A 175-c.f.m. compressor will provide an adequate air supply for both drilling and moving, but the unit has ample power to tow portable compressors up to and including 600-c.f.m. size. Sprockets are provided on the air motors to enable two alternative travelling speeds of 1–1½ m.p.h. and 2–3 m.p.h. At the lower ratio a gradient of 1 in 2½ can be climbed. The drill is basically the company's Mark III "Universal" machine for putting down 4-in. or 3⅛-in. diameter holes at any angle from vertical to horizontal to 150 ft. by either dry or wet methods. A rack is provided for the interconnecting tubes. In the photograph the mast is shown in position for drilling at an angle and the chain guards have been left off the air motors to show the alternative gears.

Constant Weight Feeder

Illustrated here is a constant weight feeder known as the Feedoweight, of which particulars have been made available by the **Merrick Scale Manufacturing Co., Ltd.,** of Albert Street, Bulwell, Nottingham. The machine has been developed by the American parent company as a result of nearly 60 years' experience of continuous weighing of bulk materials and is capable of an accurate performance in dealing with almost all classes of bulk materials from powders to lumps. It is suitable for ensuring peak and accurate feed of a single material or, when used in multiples, for material proportioning and blending with a high degree of consistency of quality of resulting product. Many accessories are available, such as a tachometer generator and indicator which enables the operator to preset output over its entire capacity range. Controls and belt speed change may be effected from the remote position and a remote six-figure set-back totalizer can be fitted in conjunction with the master weight totalizer. To provide a permanent continuous record an electrically-operated continuous strip chart recorder, working in conjunction with a frequency responsive tachometer generator, can be supplied or a circular chart recorder operating from an electrical contactor device and



Constant Weight Feeder.



Compressor for Power Stowing.

marked on the master weight totalizer is available.

Compressor for Power Stowing

A new horizontally-opposed compressor designed primarily for use in power-stowing operations underground has been developed by **Tilghman's, Ltd.,** of Broadheath, Altrincham, Cheshire. Two machines of this type, one of which is illustrated, are intended for such work in Cadley Hill colliery.

In formulating the compressor design Tilghman's have worked in conjunction with officials of the National Coal Board, a special machine being needed, it is suggested, because if air is used from the air main there will be serious wastage of power, since it may be necessary to reduce the pressure from, say, 80 p.s.i. down to 15 p.s.i. and on a suitable unit which requires something like 2,000 c.f.m., this can represent a wastage in power of approximately 250% or 300%. It is obvious that operating pressures will vary considerably since if the material is dense it will require a high pressure, while if it is light it can be carried at a comparatively low pressure. In addition the machine must be easily started and stopped, by remote control if necessary, have a low noise output, and have dimensions which will make it suitable for going down a shaft and yet still have access for installation and maintenance. For these reasons the machine must be rugged and simple and suitable for mounting on a skid, as well as being completely self-contained. The compressor now available is thought to fill all these requirements. It is a 4-cylinder horizontally-opposed reciprocating machine with four 11½ in. diameter cylinders and of the single-acting trunk piston type. It has a stroke of 5½ in., operates at 1,000 r.p.m., and has an infinitely variable compression ratio and is simple to start. The machine can easily be unloaded for running light and has a low order of noise level, an air maze combined silencer and inlet filter reducing this even further. It is 11 ft. 6 in. by 5 ft. by 4 ft. 6 in. high and mounted on a specially designed skid as shown in the illustration. Machines of this type are complete with their own water-cooling system and have mounted on the skid a complete Teddington control panel.

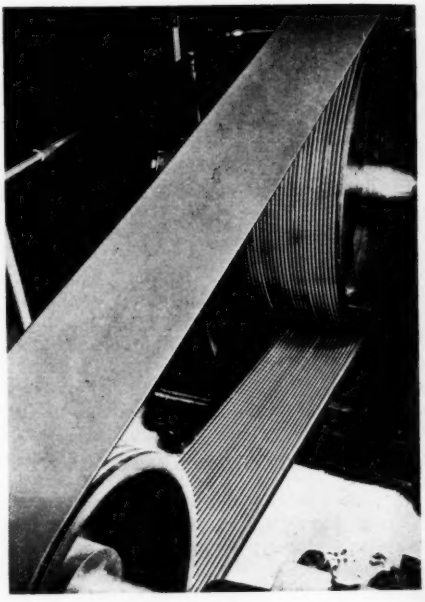
The makers state that a unit of the type described will be on show at the forthcoming Compressed Air and Hydraulics Exhibition which is being held at Olympia, London, from April 25–29.

Anti-Corrosion Paint

A new paint suitable for steel or weathered galvanized iron is shortly to be made available in this country. Developed in the United States by the Vita-Var Corporation, of Newark, New Jersey, particulars are now available through **Anthony Edwards and Associates,** of 57, Talgarth Road, London, W. 14. After lengthy tests in corrosive atmospheres Vita-Var stainless-steel paint No. 13448, which contains a mixture of stainless-steel flake (18% Cr, 8% Ni) and several non-metallic pigments in a long oil alkyd resin vehicle is now being marketed. It is considered that it will afford protection to steel and iron structures for at least 12 years. The paint is designed for use as a finishing coat and when first applied it is medium grey in colour with a semi-gloss finish. After about two years it becomes lighter and brighter in appearance and

closely resembles uncoated stainless steel. It may be applied to iron and steel by brush, spray, or roller direct over old paint, provided it is in good condition. Bare metal should be primed with a Vita-Var corrosion-resistant primer (No. 14142). With galvanized iron bare metal is coated with a red Vita-Var primer (No. 14399) which is supplied in two separate containers; one of these holds red lead and vehicle and the other dry metallic zinc dust. Before application the zinc dust is added to the red lead and mixed very thoroughly. It is not necessary to prime galvanized iron which has been previously painted provided that the old coat is in good condition. Primers for steel and galvanized and non-galvanized iron can be applied by brush, roller, and spray. Mineral spirits may be used as a thinning agent if required. One gallon of top coat and both types of primers will cover an area of 450–500 sq. ft.

The stainless-steel base of No. 13448 paint gives it very high protective qualities against corrosion. In addition the paint has a very smooth finish which sheds dust and dirt. Annual maintenance costs of many types of plant are claimed to be reduced by 30% in teets conducted by the manufacturer.



" M " Section " Poly-V " Belt.

Novel Approach to Power Transmission

At a Press conference last month **Turner Brothers Asbestos Co., Ltd.,** of Rochdale, introduced and demonstrated applications of the " Poly-V " drive and various types of transmission belts it uses. This product has been introduced into this country from the United States where it is already known under the same name and is manufactured by Raybestos-Manhattan, Inc., of Passaic, New Jersey.

As may be seen from the illustration the belt employed is flat, with a series of parallel V-shaped ribs moulded on its inner surface. These form the driving surface of the belt and completely fill mating grooves on the pulleys. Two benefits are thus obtained: First, the load-carrying member extends across the full face of the drive, unlike the multiple V-belt drive in which part of the total drive width available is wasted by the space between belts, and, secondly, the grooved inner face of the belt has about twice the surface area in contact with the pulleys when compared with a multiple-belt drive of similar widths. These two principal features, it is pointed out, mean that the Poly-V drive can transmit the same load in less space or a greater load in the same space as a multiple-belt drive. An increased drive capacity of 50 per cent. is, in fact, claimed.

The belts are made in three different profiles. Two of these—the " L " and " M "—between them cover the whole range of power transmission now covered by five different V-belt cross-sections (none of which is interchangeable). This is because the load-carrying member of the drive is carried above and outside the pulley grooves and is thus quite independent of the size and shape of groove. Furthermore, the frequent difficulties met with in matching up V-belts are avoided. For light drives where single V-belts are normally used there is a smaller section available. This is the " J " section which has extreme flexibility and offers freedom from vibration—characteristics which overcome the problems usually associated with many small drives.

Among applications indicated are the following drives: Agitators and flotation machines, compressors, conveyors, crushing and grinding machinery of all kinds, fans and blowers, electric motors and generators, pumps, and vibrating or revolving screens.

Personal

E. J. D. BROWN is home from Sierra Leone.

F. BERNARD CHAMPNESS has retired from Fraser and Chalmers Engineering Works to take up consulting practice.

J. A. COWPERTHWAITE is now in Southern Rhodesia.

GEORGE HARVEY has left for Ghana.

H. A. LAVERS is visiting Kenya.

D. H. MCLAUGHLIN, Chairman of the Homestake Mining Co., of South Dakota, has been on a visit to South Africa as the guest of the Chamber of Mines.

W. L. G. MUIR is returning from Sierra Leone.

W. J. PALK has left the Netherlands West Indies for a visit to Italy.

W. G. PYNE MERCIER has retired from Government service as Government Mining Engineer, after about 17 years in the Department of Mines and an association of 27 years with the mining industry.

R. B. SMART has retired after 33 years with the Consolidated Gold Fields group, including the position of manager of the Sub Nigel and Vlakfontein mines.

M. SMYTH is now in Ghana.

KENNETH STUART LOW, who died on December 31, aged 75, was at the Royal School of Mines from 1903 to 1906. A metallurgical chemist, he had for most of his career been engaged in the chemical engineering industry in this country. He was a Fellow of the Chemical Society and an Associate Member of the Institution of Mechanical Engineers.

FREDERICK FARRINGTON KETT, who died suddenly on March 13 at his home in San Mateo, California, aged 78, had until his retirement in 1950 been long employed by the Vanadium Corporation of America, the last 10 years as general manager of the company's mining department. Mr. Kett was born in Chicago on October 7, 1882, his parents having come originally from New England. He attended public schools in Chicago and entered the Armour Institute, which later became the Illinois Institute of Technology. About 1900 he enrolled at the Royal School of Mines from which he graduated in 1903. His first job after graduation was at the Melones gold mines in Calaveras County, California, later being engaged to build the first concentrator at the Braden copper mine in Chile. From 1911 to 1917 he was engaged in consulting and other mining activities in various European countries—principally in Russia. A few years later he went to Mexico for the Vanadium Corporation but in 1925 he returned to Siberia for British interests to develop a gold property for the Ayan Corporation, Ltd. Two years later, returning to London, he was sent to Aroa in Venezuela for the South American Copper Syndicate where he supervised the erection of a flotation plant among other duties of a two-year stint. In 1935 he rejoined the Vanadium Corporation as an assistant to Charles Rees who was in charge of mining operations. His first assignment was the further development of the ilmenite operation in Virgina for the production of titanium. When Mr. Rees died in 1939 Mr. Kett was appointed general manager of the Corporation's mining division. Following his retirement from active work in 1950, Mr. Kett, who was a member of the American Institute of Mining, Metallurgical, and Petroleum Engineers, and of the Institution of Mining and Metallurgy, made an examination for Grace and Co. of tin properties in Bolivia, and later for the Firestone Rubber Co. he made a survey of the mineral resources of its vast concessions in Liberia.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Associate Member to Member.—Alexander Wilson CLARK, A.R.S.M., B.Sc. (*Monrovia*); Laurence Clive CURTIS, A.C.S.M. (*Hutti, India*); John Edward HARPER (*Kalulushi*); Gordon Leslie HATHERLY, B.Sc. (*Elliot Lake*); Sidney Cecil PEARCE, A.R.S.M., Ph.D. (*Chislehurst*).

Associate Member.—David William ALLEN, B.E. (*Kitwe*); John Ellis LLOYD, B.Sc. (*Manchester*); Cecil Gerald Philip SACK, B.Sc. (*Salisbury, S. Rhodesia*); Roy Kenneth TAYLOR, B.Sc. (*Thorpe Hesley*); Cornelius Jansen DE VILLERS, B.Sc. (*Kitwe*); Kenneth Edward WILDERSPIN (*Church Crookham*).

Student or Affiliate to Associate Member.—Alec Gerald BANNISTER-BROWN, A.C.S.M. (*Elliot Lake*); Arthur George DARNLEY, Ph.D. (*Greenford, Middx.*); John Patrick HIGGINS, A.C.S.M. (*Hangha, Sierra Leone*); Edward Walter INETT, B.Sc. (*Kenilworth*); James Bateman KITCHIN, A.C.S.M. (*Newcastle-on-Tyne*); Christopher Blayney ROPER, A.C.S.M. (*Kitwe*).

Affiliate.—George Soulby HUTTON (*Camborne*); Jeffrey Stafford ROBINS (*Fort Victoria, S. Rhodesia*).

Student.—Maung AUNGBO, B.Sc. (*Camborne*), (*Rangoon*); Alfred Kwao AYIVOR (*Camborne*); Robin George BURN (*Camborne*); Siew Hung CHAN (*Camborne*); Jacobus Smuts DE VILLIERS, M.Sc. (*Montreal*); Harry Norman GRAY (*Camborne*); Peter George GREGORY (*Camborne*); Edwin Peter GUSH, B.Sc. (*Welkom*); Ian Kennerley HASPELL (*Camborne*); Christopher Jon Mortimer JEWISON (*Prestbury*); Andrew Gavin MACKAY (*Camborne*); Vir Kendra SINGH, A.H.-W.C. (*Edinburgh*); William White WALKER (*Camborne*); Frederick William WESTLAKE (*Camborne*); Lionel Alfred YORK, B.Sc. (*Brampton, Ontario*).

Metal Markets

During March [1]

Copper.—The copper market in March has been an unsettled affair. Essentially, ups and downs in price have reflected the ascendency in the consciousness of market observers of the tight nearby position, or the more freely supplied medium and long-term prospect. It is now universally accepted that, given a relatively uninterrupted flow of copper from the world's producing centres (on which point, of course, a good deal of doubt always seems to attend), copper supplies during 1960 will be more than adequate to meet demand, notwithstanding the fact that outside the U.S.A. it is showing a healthy expansive trend. In this connexion it may be noted in passing that inside the U.S.A. consumption is not

[1] Recent Prices, pp. 208, 248.
[2] See Table, p. 248.

running according to the form forecast at the end of last year and in the early part of 1960; there has been a certain resurgence of recessionary feeling there and copper has been in somewhat reduced demand. A measure of this is the fact that in the early part of the year, any spot copper supplies which dealers could offer in the U.S.A., commanded a premium over the producers' price (of 33 cents a lb.) of up to 5 cents per lb. To-day dealers are lucky to sell at a discount of 1 cent per lb.

The spot copper shortage which has certainly been noticeable as far as physical metal in Europe is concerned has been accentuated in the London Metal Exchange technical position. Stocks there, in response to consumer pressure, have, not really surprisingly, shrunk quite noticeably in the first quarter of this year. Inevitably this has resulted in somewhat inflated spot prices on the London Metal Exchange and a very wide backwardation being maintained, albeit not quite so serious on the whole as was seen during February. It has been the spot position too which has responded most acutely to the threats of production interruption which have materialized during the month. Riots in the Congo and a one-day strike in Chile have both helped to emphasize this aspect.

U.K. copper consumption during January amounted to 57,316 tons, of which 41,741 tons was refined. Production of primary refined metal produced in this country in the same month totalled 6,687 tons and of secondary 8,455 tons. Stocks of refined copper showed an increase over the December figure at 49,875 tons, as did blister at 11,213 tons.

Tin.—Even with the feature in March—*i.e.*, the outcome of the latest Tin Council meeting—the tin market has not been particularly exciting.[1] Following the Council meeting mentioned it was learned that the apparently very positive step had been taken of raising the second quarter quota to 37,000 tons for all producing members or, as near as makes no difference, 100% of exports in the period prior to the introduction of control. In making this announcement, however, the Council immediately pointed out that they had taken into consideration the probability of non-fulfilment of the quota and estimated actual exports at little over 35,000 tons. It was subsequently elucidated in trade circles that this deficiency was probably totally attributable to Bolivia which, it was also learned in March, was most unlikely to fill her first quarter quota either. Figures released at the very end of March suggest Bolivia's exports in round figures of 4,000 tons per quarter are likely, against a quota of over 7,000 tons. Subsequently some rather childish remarks have been made in Bolivia—such as, that she might leave the Tin Agreement and that quotas are being artificially raised by consumers to hold prices down. These are not taken very seriously, as the chronic maladies of the Bolivian tin-mining industry are well known. The next feature of interest this year will be the deliberations under United Nations auspicies to consider the nature of a new Tin Agreement, if any, to run from July, 1961.

U.K. tin consumption during January showed a slight decline at 1,878 tons, as compared with the December figure of 1,997 tons. Production was also down at 2,377 tons (new metal), as were stocks at 10,884 tons against the December figure of 11,523 tons.

Lead.—The lead position is a rather mixed one at present. As long as the existence of artificial (but admittedly voluntary) restrictions on world lead supplies by certain producing companies are ignored the position looks very healthy and prices stand at corresponding levels.[1] However, the existence of such restrictions cannot be ignored as long as they are definitely necessary in view of the size of producing companies' stocks. The actual rate of consumption, conspicuously in Europe, is really very satisfactory, especially when compared with the performance of consuming industries in recent years. It is not the case that the same position obtains in the U.S.A., although the situation is certainly not as bad as it has been. The season for U.S. political protectionism has again been revived and one Bill has been put forward to assure small producers a return of as much as 17 cents per lb. on their lead. The matter was shelved pending availability of the U.S. Tariff Commission report on imports which has just been received; this refuses to recommend higher duties in lieu of quotas.

Lead stocks in January showed a decline at 44,290 tons, as compared with 48,005 tons in December. Of the January figure, 36,470 tons were imported and 7,820 tons English refined. Production was also down at 7,729 tons, against the previous month's figure of 7,881 tons.

Zinc.—Like copper, zinc is suffering from a somewhat technical position on the London Metal Exchange[1] due to the shortage of spot supplies there, as measured by the low level of stocks which is somewhat more accentuated than the physical position in Europe.[1] However, it is true to say that European physical supplies are by no means abundant, notwithstanding the increase in supplies which those producers who restricted supplies last year are now making available. Moreover, to this should be added some Mexican zinc smelted on toll in the U.S.A., but unable to go into consumption because of import quotas, and some Russian high-grade zinc, the rate of arrival of which has been high in the early part of this year. This technical situation has highlighted some of the problems attendant on new London Metal Exchange lead and zinc contracts, the introduction of which at some future date was approved by a majority meeting of members during March. The new contracts will bring lead and zinc trading exactly into line with the copper and tin basis. This means that metals will be sold in warehouse and will have a daily settlement. It is feared that these factors may result in producers being even less inclined to sell metal through the London Metal Exchange—owing to the need to incur warehouse charges and to the necessity to deliver on a specified day—than they are at present. This would, of course, further reduce the level of stocks in L.M.E. warehouses and make the market more than ever susceptible to becoming "technical".

Zinc stocks showed a sharp rise at the end of January at 48,337 tons (37,162 tons in December). Of this total consumers held 18,682 tons. Production fell slightly to 6,538 tons, against 7,024 tons a month earlier.

Iron and Steel.—The U.K. steel industry is now virtually at full stretch. In February steel-making operations rose to a rate of over 25,000,000 tons a year for the first time ever and in recent weeks have attained an annual rate of 25,200,000 tons. Pig-iron output has been rising to meet the growing requirements of hot metal and in February was a record at an annual rate of 15,680,000 tons.

[1] See Table, p. 248.

Almost every product is in keen demand from consumers, but a growing amount of steel is moving into stock and as shortages appear many buyers are probably tending to over-order. Sheets, strip, wire rods, light sections, tinplate, and stainless steel are all enjoying brisk conditions and heavy sections and plates, too, are now in heavy demand. It is only railway and colliery material and some sizes of oil pipe and heavy forgings which are not in very good demand; no immediate improvement can be expected.

With the re-rollers of bars, light sections, and strip so active, the pressure on supplies of semis has become acute and once again consumers have had to turn to overseas sources. In February there was a sharp rise in imports of semi-finished steel. The other principal steel item being imported is sheet steel. Mills here are still unable to cope with the tremendous needs of motor-car makers and other users and already in the first two months arrivals have totalled nearly 90,000 tons.

U.K. mills are active on the export markets and big tonnages are still going to the U.S.A. as a result of orders placed during the big strike there. Tinplate exports in particular are booming and in the first two months of this year reached 107,197 tons, against 79,238 tons in the same period of 1959.

Iron Ore.—Imports of iron ore into the U.K. are rising and in the first two months of this year totalled 2,646,496 tons, against 1,894,899 tons in January–February, 1959. Sweden continues to be the biggest single supplier. Stocks of ore at the blast-furnaces are adequate to support a high rate of iron-making activity.

Aluminium.—The big event of the month, market-wise, was the British Government's announcement on March 4 that it was to release its remaining stock-pile metal, which totals altogether 37,000 tons. So far there has been no marked reaction in the trade to this development and for the most part it is extremely unlikely that there will be any in the future. The Government's policy—a policy that has been increasingly adopted with regard to stock-pile disposals in recent months—is to sell the metal back to the original supplier, in this case Aluminium Union—or, rather, to its successor, Alcan (U.K.). When one remembers that that company has as much interest as any other in the trade in maintaining a stable supply/demand relationship, it becomes obvious that the Government move should ensure, in so far as anything can ensure, that the actual release of physical metal takes place only in easy stages. Besides this there is the fact that the Government disposal to Alcan (U.K.) will also be made only in easy stages, over a total four-year period. At the same time, when the announcement was made, the Alcan organization had already taken up 10,000 tons of the metal involved. On the basis of current consumption in this country, of which Alcan supplies about one-half, this represents only about 3½% of the market's total annual requirements. The remaining 27,000 tons, if released in equal tonnages each year, should account for an even smaller percentage, assuming a constant rate of consumption in each of the next four years.

As things stand, however, all the prospects are for further increases in consumption of aluminium after last year's record figures of 288,955 long tons for primary ingots and 350,649 tons for semis. These figures compare with 232,499 tons and 283,577 tons, respectively, in 1958, and with previous records of 286,195 tons and 328,567 tons in 1955.

Antimony.—Keen Japanese enquiry during the last few weeks has caused a certain stiffening in the World antimony ore market. United Kingdom c.i.f. prices for 50–55% and 60% ore were advanced mid-way through the month by 6d. in each instance, the new levels being 19s. to 20s. and 20s. to 21s., respectively. English regulus is still fetching £197 10s. on the home market for 99·6% material, while 99% remains at £190 a ton.

Arsenic.—There were no developments in the market for arsenic during March. Arsenic metal is still quoted at £400 a ton in the United Kingdom while arsenic trioxide, ex stock, is still fetching £40 to £45 a ton.

Bismuth.—Trading in bismuth remains devoid of any new features and the United Kingdom price for 1-ton lots, ex warehouse, is still given as a nominal 16s. per lb.

Cobalt.—The more liberal supplies of cobalt metal which became available recently resulted in an easing of prices with effect from March 1. The United Kingdom open-market price for cobalt metal now stands at 12s. a lb., delivered. The contract price has been reduced to 10s. 9d. a lb., delivered, as compared with 12s. 6d. before. Black and grey oxides are now quoted in this country at 7s. 10d. a lb. and 8s. 4d. a lb., against 9s. 1d. and 9s. 8d., previously.

Cadmium.—Sellers of United Kingdom and Empire cadmium advanced their prices by 6d. a lb. to 10s. 6d. half way through March—fully three months after the state of the market had indicated such a move. Only Russian and Polish metal, of which there is very little available in this country anyway, can now be obtained at less than the United Kingdom price. Other material, particularly Belgian, which was once available duty paid at a discount below the home price for U.K. and Empire refined, now fetches a premium, when there is any to be had at all, at up to 10s. 9d. a lb.

Chromium.—Chromium metal went through another featureless period in March, so far as the market was concerned. The price is still quoted as being in the range 6s. 11d. to 7s. 4d. a lb.

Tantalum.—Tantalum ore has been in rather better demand of late, particularly from European consumers, and this was reflected in the early half of the month by a rise of some 50s. a unit in the c.i.f. price for 60% ore, which is now 700s. to 750s.

Platinum.—Sellers of U.K. and Empire refined platinum continued to do good business throughout March at a price of £30 5s. per troy oz. Imported metal from other sources (mainly Russia) has not been selling quite so well, however, and the open-market quotation in this country has been shaded from its £28 10s. to £29 level, established at the end of January, to a figure rather nearer £28 to £29 10s.

Iridium.—The main sellers of iridium sponge and powder in the United Kingdom have continued to sell material at £26 15s. per troy oz. Smaller suppliers, however, have been shading their quotations recently so that the range now extends from £23 to £26 15s. a troy oz., as against £24 to £26 15s. in February.

Palladium.—Palladium, too, has been selling at its February level of £9 7s. 6d. per troy oz., although some dealers have had to shade their quotations to £8 10s.

Osmium.—Osmium quotations are again unaltered at £22 to £32 5s. per troy oz. (nominal).

Tellurium.—Tellurium prices remained throughout March at the levels operating the previous month—namely, 21s. 6d. to 25s. a lb. for lump and powder 99% to 99·5%. Tellurium sticks, minimum 99·5%, are still quoted at 30s. a lb.

Tungsten.—Russia re-entered the tungsten-ore market early in March and, with something like 450 tons of such material overhanging the market, prices began to tail off almost from the outset. By March 10 they had fallen from 156s. to 161s. a unit, c.i.f. Europe, to only 149s. to 154s. After a further fall to 147s. 6d. to 152s. 6d. a unit, however, they steadied themselves until the very end of the month, when a further 6d. reduction took place. For most of the month buying interest was quiet—certainly much quieter than for some little time past—although there were a few spurts of activity. The general market tone at the end of the month was still weak.

Nickel.—Alongside the gloomy news from Cuba (where new mining laws are likely to prove so much of a bug-bear to the Moa Bay concern that it has decided to suspend operations from the beginning of April), it is pleasant to hear of one man in the industry with a happy outlook. Such a man is the president of Falconbridge Nickel Mines, Mr. H. Fraser. Speaking in New York last month, he said that world usage of nickel was rising at an average rate of 12,500 tons a year and was likely to continue to do so as long as stainless-steel production continued to rise. On the other hand, he did not see any immediate price change in the offing. The latter is not surprising for there is certainly no shortage of nickel at the moment, despite certain recently expressed opinions to the contrary (notably from Italian consumers, although U.S. buyers seem to have had the idea for a very long time regardless of all the evidence to the contrary). The United Kingdom price for refined nickel delivered to customers' works in lots of 1 ton and over is £600 a ton.

Chrome Ore.—On an international front American consumers have been showing rather more interest in new supplies of chrome ore recently than for some time past. There has been a U.S. barter inquiry in recent weeks for a substantial tonnage of Turkish ore, but it seems that present stocks in Turkey are mainly of another grade than that requested. Present Turkish stocks of the requisite grade amount to only about one-tenth of the 200,000 tons said to be required.

In the United Kingdom and Europe consumption of metallurgical ore is running at a good rate, but some traders are still inclined to a pessimistic view of immediate prospects, maintaining that many consumers appear to have their likely needs for the next few months already covered by existing contracts. Prices remain the same as for some time past, Rhodesian and Turkish metallurgical grades again being quoted at £15 15s. and (nominally) $33.50 a ton respectively.

Molybdenite.—Quotations are again unaltered at 8s. 11d. a lb. of Mo contained for American Climax material f.o.b. mine and 9s. 3½d. a lb. c.i.f. for material from elsewhere.

Manganese Ore.—The manganese-ore market is still very depressed, but there is a growing body of opinion that a little additional United States buying may be on the way as a result of the continued high rate of steel production. On the other hand, some observers think that present stocks may be enough for a year's requirements. In Europe consumers' supplies are thought to be sufficient for a further 5 or 6 months at least. It is not surprising, therefore, that prices show no signs of increasing. The c.i.f. Europe price for 46% to 48% ore remains at a nominal 68d. to 73d.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum, 99·75% ; Copper, electro ; Lead, minimum, 99·75% ; and Zinc, minimum, 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Mar. 10	786 10	785 10	253 5	238 5	76 2½	75 1¼	88 13¾	87 11½
11	786 0	785 10	247 15	235 12½	75 15	74 16¼	88 18¾	87 12½
14	787 0	786 15	243 15	233 5	75 8¾	74 11¼	88 15	87 8¾
15	792 0	790 5	247 15	234 17½	76 2½	75 2½	88 11¼	87 13¾
16	792 0	790 10	249 15	235 17½	76 16¼	75 13¾	89 5	87 17½
17	791 10	790 5	250 10	235 17½	76 12½	75 11¼	89 12½	88 2½
18	791 0	789 5	253 5	236 2½	76 18¾	75 16½	90 11¼	88 18¾
21	789 10	788 5	256 5	238 2½	77 8¾	76 6¼	91 2½	89 12½
22	789 0	787 15	255 7½	237 12½	77 13¾	76 13¾	92 5	90 17½
23	788 10	786 5	253 5	237 7½	77 6¼	76 5	92 6¼	90 12½
24	786 10	784 15	253 15	237 15	77 11¼	76 13¾	92 18¾	91 7½
25	787 10	786 0	257 5	240 15	76 12½	75 17½	92 7½	90 17½
28	787 0	786 5	258 10	240 15	76 11¼	76 3¾	93 2½	91 6¼
29	789 0	787 5	255 15	239 5	76 11¼	76 1¼	93 7½	91 6¼
30	789 10	787 15	251 5	237 7½	76 7½	75 18¾	92 17½	90 12½
31	789 10	787 15	254 10	240 5	76 11¼	75 16¼	93 7½	90 18¾
Apr. 1	789 10	787 5	254 5	240 17½	76 16¼	76 3¾	92 17½	90 18¾
4	788 10	786 10	249 10	238 5	77 0	75 18¾	90 12½	88 12½
5	790 10	786 5	253 15	240 17½	78 0	76 16¼	91 7½	89 12½
6	792 0	786 10	253 15	240 12½	78 2½	77 3¾	91 12½	89 13¾
7	790 0	786 15	255 5	240 7½	77 17½	76 16¼	91 16¼	89 11¼
8	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	Feb.		Mar.	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	124,000	81,322	126,000	82,206
Brakpan	134,000	16,474	146,000	17,380
Buffelsfontein‡	143,000	56,188	130,000	51,402
City Deep	109,000	22,983	113,000	24,008
Cons. Main Reef	73,000	14,158	70,000	14,734
Crown Mines	196,000	32,698	206,000	34,224
Daggafontein	231,000	46,457	232,000	46,650
Doornfontein‡	94,000	38,413	93,000	38,016
D'rb'n Roodeport Deep	179,000	32,932	196,000	35,734
East Champ D'Or‡	12,000	280	12,000	286
East Daggafontein	104,000	17,441	105,000	17,851
East Geduld	128,000	37,760	139,000	40,658
East Rand P.M.	206,000	53,706	228,000	57,755
Eastern Transvaal Consol	19,000	6,219	18,900	6,303
Ellaton‡	28,000	6,452	26,000	6,196
Freddies Consol.	58,000	13,385	56,000	12,746
Free State Geduld	94,000	81,076	90,000	77,626
Geduld	72,000	13,143	75,000	13,510
Government G.M. Areas‡	51,000	10,350	54,000	11,080
Grootvlei Proprietary	210,000	43,891	220,000	45,873
Harmony Gold Mining	142,000	57,019	149,000	59,832
Hartebeestfontein‡	100,000	47,250	100,000	47,000
Libanon	112,000	26,647	112,000	26,631
Loraine	76,000	16,150	67,000	14,238
Luipaards Vlei‡	115,000	12,923	120,000	13,456
Marievale Consolidated	96,000	23,616	102,000	24,888
Merriespruit‡	—	—	—	—
Modderfontein East	131,000	12,710	141,000	13,413
New Kleinfontein	74,000	9,701	81,000	10,720
New Klerksdorp‡	10,700	1,170	10,300	1,255
President Brand	115,000	93,276	110,000	89,101
President Steyn	100,000	38,805	95,000	36,859
Rand Leases	179,000	27,298	177,500	26,591
Randfontein‡	181,000	12,563	182,000	12,367
Rietfontein Consolid't'd.	16,000	4,202	16,000	4,178
Robinson Deep	44,000	8,940	45,000	9,801
Rose Deep	26,000	4,406	27,000	4,355
St. Helena Gold Mines	155,000	51,928	150,000	50,255
Simmer and Jack	79,000	13,123	78,000	13,971
S. African Land and Ex.	94,000	19,615	96,500	20,024
S. Roodepoort M.R.	29,000	6,931	30,000	7,069
Spaarwater Gold	10,600	3,301	11,000	3,388
Springs	104,000	14,406	102,000	14,353
Stilfontein Gold Mining‡	147,000	66,150	147,000	66,200
Sub Nigel	64,000	15,030	66,500	15,252
Transvaal G.M. Estates	5,700	1,954	—	—
Vaal Reefs‡	94,000	42,300	90,000	28,441
Van Dyk Consolidated	70,000	11,886	76,000	12,821
Venterspost Gold	124,000	31,403	109,000	28,177
Village Main Reef	32,100	4,910	30,400	4,713
Virginia O.F.S.‡	134,000	30,284	120,000	26,700
Vlakfontein	50,000	17,989	52,000	18,474
Vogelstruisbult‡	86,000	18,284	86,000	18,383
Welkom Gold Mining	98,000	30,963	90,000	28,441
West Driefontein‡	118,000	108,514	112,000	102,992
West Rand Consol.‡	199,000	19,302	198,000	19,174
Western Holdings	148,000	98,790	144,000	96,120
Western Reefs	135,000	37,935	131,000	36,877
Winkelhaak	79,000	24,214	83,000	25,730
Witwatersrand Nigel	18,500	4,288	19,400	4,403

† 249s. 8d. * 249s. 10d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Dec., 1958	16,540,150	67 7	47 10	19 9	25,934,441
Jan., 1959	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,743,500	68 0	45 4	22 8	25,934,881
April	—	—	—	—	—
May	—	—	—	—	—
June	17,845,100	69 1	45 2	23 11	28,473,191
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,214,200	70 5	45 2	25 3	30,140,529
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,670,000	72 2	45 10	26 4	30,559,937

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
March, 1959	1,561,196	32,271	1,593,467
April	1,616,891	36,815	1,653,706
May	1,641,990	30,371	1,672,361
June	1,665,503	34,465	1,699,968
July	1,700,968	48,414	1,749,382
August	1,699,098	36,052	1,735,150
September	1,701,485	36,567	1,738,052
October	1,718,916	33,576	1,752,492
November	1,688,379	34,903	1,723,282
December	1,662,043	31,309	1,693,352
January, 1960	1,701,110	34,651	1,735,761
February	1,675,248	38,859	1,714,107

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
June 30, 1959	383,903	33,146	417,049
July 31	381,190	33,295	414,485
August 31	377,257	32,994	410,251
September 30	371,813	32,903	404,716
October 31	365,833	32,567	398,400
November 30	358,746	32,067	390,813
December 31	354,058	31,963	386,021
January 31, 1960	372,254	31,993	404,247
February 29	385,027	32,144	417,171

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Mar. 5.		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	23,800	3,516	4,290
Electrolytic Zinc	15,068	610	4,048
Lake George	16,500	1,331	2,665
Mount Isa Mines**	61,931	4,060†	3,031
New Broken Hill	50,520	6,434	12,843
North Broken Hill	30,706	6,030	6,776
Zinc Corp.	60,300	9,425	10,783
Rhodesia Broken Hill*	—	—	—

* 3 Mths. ** Copper 3,305 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Cam and Motor	31,867	—	—	—
Falcon Mines	20,300	3,907	20,000	3,850
Globe and Phœnix	6,000	—	6,100	3,027
Motapa Gold Mining	—	—	—	—
Mazoe	2,833	—	—	—
Coronation Syndicate	12,252	—	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	February		March	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	60,521	13,494	59,095	13,210
Ariston Gold Mines	40,390	13,022	40,500	13,307
Ashanti Goldfields	35,500	29,55	35,500	29,650
Bibiani	32,000	6,90	33,000	7,100
Bremang	—	4,700	—	—
Ghana Main Reef	12,700	4,121	11,978	4,153
Konongo	7,000	3,565	7,200	3,562
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1958		1959	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,305	46,553	46,489	18,077
February	43,591	21,313	43,366	19,806
March	43,830	8,179	48,397	17,394
April	46,587	22,573	—	—
May	46,015	19,937	46,423	46,280
June	46,453	20,105	49,995	31,386
July	44,244	19,170	46,512	32,734
August	47,484	20,549	38,727	29,178
September	48,295	21,141	56,760	33,837
October	46,311	6,342	48,528	32,314
November	47,994	16,435	47,916	31,092
December	48,888	30,724	47,452	31,175

WESTRALIAN GOLD PRODUCTION

	1958	1959	1960
	Oz.	Oz.	Oz.
January	66,562	63,924	64,794
February	65,965	65,035	—
March	65,420	65,408	—
April	60,855	62,686	—
May	64,196	64,184	—
June	67,929	74,590	—
July	81,106	78,974	—
August	68,610	—	—
September	68,744	—	—
October	70,128	70,427	—
November	67,562	68,858	—
December	120,106	117,474	—
Total	867,187	866,600	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Mar. 1		To Mar. 29	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,288	6,677	13,981	7,359
Gold Mines of Kalgoorlie	40,996	11,064	41,093	11,664
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	35,035	5,590	31,380	4,397
Lake View and Star*	—	—	—	—
North Kalgurli	—	—	—	—
Sons of Gwalia	12,542	2,592	11,018	2,131
Mount Morgan	—	4,592	—	—

* 3 Months

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
October, 1.58	801,965	209,006	34,914	7,178,218
November	783,065	230,251	35,097	7,842,435
December	787,573	219,351	30,989	7,490,094
January, 1959	799,178	227,656	41,277	7,700,672
February	727,843	227,981	32,976	7,708,523
March	807,952	223,728	33,045	7,616,425
April	776,583	225,027	32,778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	774,749	221,814	32,172	7,498,030
August	683,819	191,598	29,141	6,428,545
September	754,208	213,772	34,139	7,116,556
October	794,030	227,192	34,733	7,558,567
November	770,437	227,176	35,262	7,660,949
December	775,803	221,377	40,807	7,388,654
Jan a , 1960	778,103	226,856	27,617	7,550,068

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Feb.		Mar.	
	Tons	Oz.	Tons.	Oz.
Clutha River	—	315	—	337
Lampa (Peru)†	—	28 950	—	36,278
New Guinea Goldfields	3,463	1,037	—	—
Yukon Consol.	—	—	—	—

† Oz. Silver : Copper, 83 tons ; 109.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (a)	Lead
1959	246,693	89,162	306,169
Provisional			
1959—January	7,744	14,523	12,946
February	—	—	—
March	—	—	—
April	—	—	—
May	—	—	—
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(a) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Jan.	Feb.	Mar.
Ampat Tin	81	80	68
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Batu Selangor	—	—	—
Berjuntai	182	201	216
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	—	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	84	110	95½
Kamunting	115	154¼	170
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	31	33	—
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	76½	68	74
Kuala Kampar	64	62½	76
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	166	205	162
Malayan	—	—	—
Malaysiam	—	7	5
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	594*
Pengkalen	—	—	—
Petaling Tin	—	—	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	39½	38	43
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	25	25	20
Southern Kinta	268	219	280
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	—	—	—
Tambah	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	33½	132	103
Tronoh	—	—	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Feb.		Mar.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	286	29	304	—
Anglo-Burma Tin *	21	—	—	—
Bangrin	49	—	75	—
Beralt	4	178†	6	174†
Bisichi	47½	30	48	32½
Ex-Lands Nigeria	41	—	44	—
Geevor	56	—	—	—
Gold and Base Metal	59	6	—	—
Jantar Nigeria	17	19	—	—
Jos Tin	12	—	—	—
Kaduna Prospectors	5	—	6	—
Kaduna Syndicate	25	—	23	—
Katu Tin	27	—	15	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	9½	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	132	—	107	—
South Bukeru	—	—	—	—
South Crofty	73	—	80	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	37½	—½	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

December, 1959.

Gold	1,664,171 oz.
Silver	174,746 oz.
Diamonds	313,129 carats.*
Coal	3,386,015 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 5,284 tons of 99·24% tons concs.
Tin	—
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	13,192 tons.
Chrome Ore	63,600 tons.
Manganese Ore	91,466 tons.
Lead Concs.	21 tons

* *November, 1959*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Jan.	Feb.
Iron Ore	tons	1,353,093	1,293,403
Manganese Ore	,,	36,066	28,309
Iron and Steel	,,	73,498	90,163
Iron Pyrites	,,	16,500	19,075
Copper Metal	,,	44,383	40,075
Tin Ore	,,	4,365	5,072
Tin Metal	,,	190	420
Lead	,,	13,062	13,052
Zinc Ore and Conc.	,,	5,528	8,702
Zinc	,,	24,715	17,616
Tungsten Ores	,,	520	662
Chrome Ore	,,	6,519	16,594
Bauxite	,,	35,330	14,687
Antimony Ore and Concs.	,,	1,218	2,551
Titanium Ore	,,	20,715	56,865
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	39	122
Sulphur	,,	41,206	41,867
Barytes	,,	2,081	5,090
Asbestos	,,	9,386	8,208
Magnesite	,,	5,684	3,502
Mica	,,	503	1,059
Graphite	,,	420	1,219
Mineral Phosphates	,,	154,337	148,888
Molybdenum Ore	,,	233	923
Nickel	cwt.	28,145	42,906
Aluminium	,,	580,656	785,453
Mercury	lb.	98,794	139,981
Bismuth	,,	142,204	50,367
Cadmium	,,	282,534	422,750
Cobalt and Cobalt Alloys	,,	409,710	124,500
Selenium	,,	40,040	22,989
Petroleum Motor Spirit	1,000 gals.	49,406	71,032
Crude	,,	542,049	1,015,734

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98-99%	,,	42	0	0
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	0	0
Boric Acid, Comml.	,,	77	0	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	9	15	0
Copper Sulphate	per ton	80	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		7	0
Hydrochloric Acid 28° Tw.	per carboy		11	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Carbonate, white	,,	120	0	0
,, Nitrate	,,	110	0	0
,, Oxide, Litharge	,,	100	10	0
,, Red	,,	108	10	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	1
Nickel Sulphate	per ton	195	0	0
Nitric Acid, 80° Tw.	per ton	32	0	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	per lb.		1	2½
,, Bromide	,,	11	2	6
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride	,,	21	0	0
,, Iodide	per lb.		6	10
,, Amyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	198	0	0
,, Sulphate, 50%	,,	20	13	0
Sal-Ammoniac	,,	70	0	0
Sodium Acetate	,,	75	10	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	10	0
,, Bichromate	per lb.		1	0
,, Carbonate (Soda Ash) 58%	,,	13	15	0
,, Chlorate	,,	91	0	0
,, Cyanide	per cwt	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	2	15	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	10	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	131	0	0
,, Oxide	,,	100	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Mar. 8, 1960 £ s. d.	Apr. 6, 1960 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	4 0 0	3 2 6
Blyvooruitzicht (2s. 6d.)	1 7 6	1 5 3
Bracken (10s.)	1 10 6	1 3 6
Brakpan (3d.)	4 9	4 6
Buffelsfontein (10s.)	2 7 6	2 0 0
City Deep	19 3	15 6
Consolidated Main Reef	16 6	15 0
Crown Mines (10s.)	1 5 6	1 1 3
Daggafontein (5s.)	1 2 3	1 0 3
Dominion Reefs (5s.)	12 6	12 0
Doornfontein (10s.)	1 13 3	1 10 3
Durban Roodepoort Deep (10s.)	1 12 6	1 6 6
East Champ d'Or (2s. 6d.)	2 3	2 0
East Daggafontein (10s.)	9 0	7 9
East Geduld (4s.)	1 1 6	19 6
East Rand Ext. (5s.)	1 5 0	1 0 0
East Rand Proprietary (10s.)	1 17 0	1 11 0
Freddies Consol.	2 3	2 0
Free State Dev. (5s.)	6 9	5 6
Free State Geduld (5s.)	8 3 9	6 15 0
Free State Saaiplaas (10s.)	16 9	15 9
Geduld	3 3 6	2 13 9
Government Gold Mining Areas (3d.)	2 9	2 6
Grootvlei (5s.)	1 1 3	19 6
Harmony (5s.)	1 16 3	1 10 3
Hartebeestfontein (10s.)	2 17 0	2 12 6
Libanon (10s.)	14 9	12 9
Loraine (10s.)	1 13 6	1 11 3
Luipaards Vlei (2s.)	8 0	7 6
Marievale (10s.)	1 7 3	1 4 3
Modderfontein B (3d.)	2 0	2 0
Modderfontein East	14 3	12 9
New Kleinfontein	4 6	3 9
New Pioneer (5s.)	1 14 3	1 10 0
New State Areas (15s. 6d.)	1 0	9
Rresident Brand (5s.)	3 10 6	2 16 3
President Steyn (5s.)	1 7 3	1 2 9
Rand Leases (9s. 3d.)	6 9	6 6
Randfontein	19 6	18 0
Rietfontein (3s.)	4 3	3 6
Robinson Deep (5s. 6d.)	5 9	5 0
Rose Deep (3s. 6d.)	9 6	9 6
St. Helena (10s.)	3 17 0	3 5 0
Simmer and Jack (1s. 6d.)	1 6	1 3
South African Land (3s. 6d.)	14 0	13 3
Springs (5d.)	1 6	1 6
Stilfontein (5s.)	1 15 3	1 11 3
Sub Nigel (3d.)	10 9	10 0
Vaal Reefs (5s.)	2 8 9	2 2 6
Van Dyk (3d.)	3 9	3 6
Venterspost (10s.)	1 0 9	17 6
Virginia (5s.)	4 6	4 0
Vlakfontein (10s.)	18 6	16 0
Vogelstruisbult (3d.)	6 6	6 0
Welkom (5s.)	19 3	16 9
West Driefontein (10s.)	9 3 9	7 18 9
West Rand Consolidated (10s.)	1 0 9	17 6
West Witwatersrand Areas (2s. 6d.)	3 12 6	2 17 6
Western Holdings (5s.)	8 3 9	6 13 9
Western Reefs (5s.)	1 9 3	1 5 0
Winkelhaak (10s.)	1 4 6	1 1 3
Witwatersrand Nigel (2s. 6d.)	1 3	1 0
Zandpan (10s.)	18 6	16 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	5 0	1 2 6
Coronation (2s. 6d.)	6 0	5 3
Falcon (5s.)	10 6	9 6
Globe and Phœnix (5s.)	1 15 0	1 12 6
Motapa (5s.)	—	—
GOLD COAST:		
Amalgamated Banket (3s.)	1 3	1 0
Ariston Gold (2s. 6d.)	4 9	4 6
Ashanti Goldfields (4s.)	1 1 3	1 0 6
Bibiani (4s.)	3 3	3 0
Bremang Gold Dredging (5s.)	3 3	3 0
Ghana Main Reef (5s.)	2 9	2 9
Konongo (2s.)	1 9	1 6
Kwahu (2s.)	6 3	6 0
Offin River (2s. 6d.)	3 6	3 3
Western Selection (5s.)	5 9	5 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 9	1 6
Gold Mines of Kalgoorlie (10s.)	7 3	7 6
Great Boulder Propriet'y (2s.), W.A.	11 6	11 3
Lake View and Star (4s.), W.A.	1 8 0	1 9 3
Mount Morgan (10s.), Q.	17 9	16 0
New Guinea Gold (4s. 3d.)	1 9	2 0
North Kalgurli (1912) (2s.), W.A.	9 9	10 0
Sons of Gwalia (10s.), W.A.	2 9	2 6
Western Mining (5s.), W.A.	9 9	9 6

	Mar. 8, 1960 £ s. d.	Apr. 6, 1960 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 12 6	1 10 0
Kentan Gold Areas	1 14 9	1 8 9
St. John d'el Rey, Brazil	4 10 0	4 15 0
Yukon Consolidated ($1)	5 0	5 2
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	1 4 6	1 1 9
Esperanza (2s. 6d.), Cyprus	2 3	2 0
Indian (2s.)	4 6	5 0
MTD (Mangula) (5s.)	11 6	10 0
Messina (5s.), Transvaal	6 6 3	5 7 6
Mount Lyell, (5s.) Tasmania	5 6	5 3
Nchanga Consolidated, N. Rhodesia	3 1 0	2 15 9
Rhokana Corporation, N. Rhodesia	3 1 6	2 12 6
Roan Antelope (5s.), N. Rhodesia	7 6	6 9
Tanganyika Concessions (10s.)	2 0 6	1 15 3
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	12 3	11 9
Burma Mines (3s. 6d.)	1 9	1 6
Consol. Zinc Corp. Ord.	3 12 0	3 16 3
Lake George (5s.), N.S.W.	3 9	3 9
Mount Isa, Queensland (5s. Aust.)	2 12 6	2 17 9
New Broken Hill (5s.), N.S.W.	2 3 0	2 3 6
North Broken Hill (5s.), N.S.W.	6 2 6	5 17 6
Rhodesia Broken Hill (5s.)	10 0	8 6
San Francisco (10s.), Mexico	19 6	18 9
TIN:		
Amalgamated Tin (5s.), Nigeria	10 0	9 9
Ampat (4s.), Malaya	12 0	13 9
Ayer Hitam (5s.), Malaya	2 19 0	3 12 6
Beralt (5s.), Portugal	1 10 6	1 10 0
Bisichi (2s. 6d.), Nigeria	5 9	5 6
Ex-Lands (2s.), Nigeria	2 6	2 6
Geevor (5s.), Cornwall	1 3 3	1 4 3
Gold Base Metals (2s. 6d.), Nigeria	1 6	2 0
Hongkong (5s.), Malaya	6 3	6 3
Jantar Nigeria (3s.)	4 6	4 6
Kaduna Syndicate (2s.), Nigeria	2 6	2 6
Kamunting (5s.), Malaya	14 6	16 3
Malayan Tin Dredging (5s.)	19 9	1 3 0
Mawchi Mines (4s.), Burma	1 6	1 6
Naraguta Extended (5s.), Nigeria	1 7	1 6
Pahang (5s.), Malaya	8 9	10 3
Ribon Valley (2s.), Nigeria	0 9	9
Siamese Synd. (5s.)	11 9	11 6
South Crofty (5s.), Cornwall	5 6	5 6
Southern Kinta (5s.), Malaya	1 6 9	1 7 6
Southern Malayan (5s.)	17 6	18 9
Southern Tronoh (5s.), Malaya	13 6	14 0
Sungei Besi (4s.), Malaya	19 3	1 2 0
Sungei Kinta, Malaya	17 6	17 6
Tekka (12s. 6d.), Malaya	5 9	7 6
Tronoh (5s.), Malaya	1 16 3	1 12 6
DIAMONDS:		
Anglo American Investment	15 15 0	12 1 3
Consol African Selection Trust (5s.)	1 4 0	1 5 0
Consolidated of S.W.A. Pref. (10s.)	11 6	9 9
De Beers Deferred (5s.)	9 3 6	7 5 0
FINANCE, Etc.		
African & European (10s.)	4 6 3	3 7 9
Anglo American Corporation (10s.)	9 18 9	7 16 3
Anglo Transvaal 'A' (5s.)	2 9 0	2 1 3
British South Africa (15s.)	5 0 0	4 1 9
British Tin Investment (10s.)	1 9 6	1 10 6
Broken Hill Proprietary	3 2 6	3 4 0
Camp Bird (10s.)	11 3	10 6
Central Mining	3 17 0	3 6 6
Central Provinces Manganese (10s.)	1 14 9	1 14 3
Consolidated Gold Fields	4 3 6	3 6 3
Consolidated Mines Selection (10s.)	2 4 9	1 12 6
Corner House	1 0 9	16 9
East Rand Consolidated (5s.)	2 3	2 0
Free State Development (5s.)	6 9	5 3
General Exploration O.F.S. (2s. 6d.)	4 9	4 3
General Mining and Finance	6 5 0	4 12 6
Hendersons (4s.)	12 9	11 0
Johannesburg Consolidated	3 7 9	2 13 9
London & Rhod. M. & L. (5s.)	7 9	6 3
London Tin Corporation (4s.)	11 0	11 0
Lydenburg Est. (5s.)	16 0	14 3
Marsman Investments (10s.)	2 6	2 6
National Mining	2 9	2 3
Rand Mines (5s.)	4 15 0	3 8 9
Rand Selection (5s.)	3 1 6	2 10 0
Rhodesian Anglo American (10s.)	4 1 0	3 11 6
Rhodesian Corporation (5s.)	3 6	3 0
Rhodesian Selection Trust (5s.)	14 3	12 3
Rio Tinto (10s.)	2 0 6	1 17 6
Selection Trust (10s.)	6 0 9	4 12 6
South West Africa Co. (3s. 4d.)	16 0	16 0
Union Corporation (2s. 6d.)	3 15 6	2 16 3
Vereeniging	6 7 4	5 5 0
West Rand Inv. Trust (10s.)	3 4 3	2 10 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Block Caving and Geological Control

The second of a series of reports descriptive of work at the San Manuel copper mine in Arizona to study the geological factors influencing block caving of the deposit has been published as Report of Investigations 5561 of the United States Bureau of Mines, the author being E. D. Wilson. Work so far, it is concluded, has shown that the principal features affecting block caving are structure, rock types, alteration, mineralization, oxidation, and presence of water, structure being fundamentally the most important. Systematic fracturing governed the extent and grade of primary ore mineralization and tangibly affects the subsidence or ground movement which extends from the mine workings to the surface because of the block caving.

The San Manuel mine, owned by the San Manuel Copper Corporation, is in the Old Hat mining district of south-eastern Pinal County, Arizona, 45 miles by paved highway north-east of Tucson and 5 miles south-west of Mammoth. The new town of San Manuel, together with the corporation offices, concentrator, and smelter, is 6 miles south of the mine. Production of copper was begun in January, 1956, and by the end of the year five stoping blocks had been developed and placed in production; associated surface subsidence had occurred prominently over an area of more than 1,382,000 sq. ft. The following year development of the 2015 and 2075 levels was in progress and the mine attained its scheduled output, 30,000 tons of ore per day, on October 16. A total of 12 stoping blocks had been placed in production by the end of the year. Because of expanding influence of the subsidence plans were made to abandon No. 2 shaft above the 1415 level. Block 7–1 was completed in February, 1958.

The principal rocks in the San Manuel area, from oldest to youngest, are generalized as follows:

Precambrian: Quartz monzonite or Oracle granite, one of the principal host rocks of the San Manuel ore-body.

Upper Cretaceous (?): Basaltic and Andesitic flows and breccia, interbedded with agglomerate or conglomerate. Forms a thick series, locally termed "Cloudburst." In places shows hypogene sulphide mineralization.

Late Cretaceous or early Tertiary: Monzonite porphyry. Intrudes the quartz monzonite and is one of the principal host rocks of the San Manuel ore-body.

Late Cretaceous or early Tertiary: Diabase dykes and irregular intrusive bodies. Mineralized in the mine area.

Tertiary: Rhyolite dykes and irregular intrusive masses. Not known to be mineralized.

Late Tertiary and early Quarternary: Gila conglomerate. Thickens from a feather edge to more than 1,300 ft. in the hanging wall of the San Manuel fault.

Late Quarternary and Recent: Alluvial slope deposits.

The monzonite porphyry intrudes the quartz monzonite in a complex manner that probably was controlled largely by a pre-existing low-angle fault zone; the principal mass of monzonite porphyry in the explored area lies above quartz monzonite and becomes thicker eastward. Numerous high- and low-angle fractures cut the rocks of the area, some of them being pre-mineral and as such of fundamental importance in localizing the mineralization; others show post-mineral movement.

Many of the latest fractures are low-angle as exemplified by the San Manuel fault. Notable among these are the East, West, and Cholla faults of N. 20° to 30° W. strikes and steep dips which seem to cut only the upper plate of the San Manuel fault.

Several examples of folding are seen in the mine area.

With a copper content of 0·5% or more the ore-body is 6,800 ft. in known length, trending N. 60° E. by more than 3,000 ft. in maximum known width. The greatest depth of drilling in the south-eastern part was 2,755 ft. and the greatest thickness of ore drilled 1,800 ft. The Gila and Cloudburst conglomerate overlie the orebody in contact with the San Manuel fault. The western (North orebody) part is generally a tabular mass dipping south-east, but that to the east of the deposit (South orebody part) expands in width, particularly at depth, and the copper-bearing zone swings southward, making it hook-shaped.

The copper ore consists of mineralized quartz monzonite, monzonite porphyry, and a small amount of diabase with little distinction in grade between rocks of different types that have undergone similar hydrothermal alteration. The ore mineralization is associated with hydrothermal rock alteration to sericite, pyrite, quartz, chlorite, kaolinite, and minor amounts of other minerals. The depth of oxidation generally ranges from 285 ft. to more than 1,600 ft. below the surface. Supergene or secondary enrichment has not taken place to any important extent. Neither the oxidation nor the enrichment is related to the present erosion surface or the present water table.

It appears that primary (hypogene) ore mineralization at San Manuel favoured areas in which the largest percentages of the east–west and north–south fractures are vertical. Conversely it seems that where mineralization is poor or lacking relatively large percentages of the east–west and north–south fractures dip 45° or less and relatively large percentages of the N. 30° W. and N. 60° W. fractures dip 60° to 90° from the horizontal. In general the ore tends to be less blocky than the barren rock.

It is considered that the shattering of the rock in the " porphyry copper " deposits was not a result of cooling of the intruded porphyry and the study reported has also demonstrated that the fracturing is systematic in strike and dip and can be explained best as the result of compressional forces of regional scope.

Long-continued studies throughout the south-west of the United States have led to the general belief that the region has been subjected to horizontal compressive forces intermittently since early geological time. The eight systems of fracturing at San Manuel agree closely with eight major shears formulated on the basis of observations, experiments, and mathematical deductions. Likewise the theoretical direction of folding and thrusting coincides with the general strike of the San Manuel fault and the observed folds of the area.

The West, East, Cholla, and other faults of N. 20° to 30° W. strike mentioned previously are interpreted as tear breaks in the upper plate of the San Manuel thrust; however, as thrust faults commonly pass into wrench (horizontal displacement) faults the Cholla fault may represent a wrench break joining with or continuing into the Mammoth fault.

Work has shown that the fractures bear some tangible relationship to the subsidence or ground movement, which, as an effect of block caving, extends from the mine workings to the surface. The fractures also may govern the angle of draw.

Drawing from undercut blocks in the San Manuel mine was started in December, 1955. By July 1, 1956, a total of 1,897,530 tons had been removed from blocks 7–1, 9–1, 6–2, and 8–2. Late in April, 1956, small ridges or bulges appeared on the surface, especially in the pavement of Highway 77 between blocks 7–1 and 9–1. Within a few weeks these deformities developed into cracks striking N. 30° W. to N. 60° W. The first crack appeared on May 7, and on June 16 a pipelike cave reached the surface about 100 ft. south-west of the centre of block 9–1.

By the middle of May, 1956, the ground movement had begun to have serious effects on the mine workings.

The initial development of surface cracks, preceded by ridges or bulges and occurring at about the same time as the first serious effects of ground movement on the mine workings, suggests that the movement causing these two phenomena was as deep-seated as the 1,475 level at least. These ridges and bulges developed midway between the heavily-drawn blocks, 7–1 and 9–1, parallel to their panel fringe drives, suggesting folding. At the same time panel 7 fringe drive caved in from the sides and top, obviously owing to horizontal compression. Also the rising of the floors and cross-shearing in the drives indicates folding due to compression.

These reactions commonly have been ascribed to crushing of interblock pillars because of the weight or shifting of the subsiding cap rock. However, such an explanation does not seem compatible with the deformation in the 1,475 level, which took place considerably north and north-east of blocks 9–1 and 7–1. In fact, deformation on the 1,475 level extended almost entirely beneath areas that were not yet undercut; also, it extended almost directly beneath the northern limiting scarp of the surface subsidence pit and north-east beyond it for 400 ft. These facts, together with the prevailing south-south-west direction of compression, suggest the following conclusion: The compressive forces causing the deformation of the mine workings were not derived from the weight of subsiding cap rock; mainly they represent residual internal stresses released by the removal of material from the stope blocks. Such residual stresses probably originated during the regional compression which, as already stated, is responsible for the fracture pattern at San Manuel.

On the 1,415 level at least damage of the mine drives tended to be localized by pre-existing zones of weakness which were related primarily to intense or strong fracturing.

Throughout the South orebody the east–west fracture system ranks first and the north–south system second. Approximately 50% to 73% of the total fractures counted there fall into these two systems. Also the majority of the east–west and north–south fractures in the ore area dip nearly 90° from the horizontal. Hence it is estimated that the angle of draw for the South orebody may be near 90° initially, but probably will decrease eventually to 45° to 55° because fractures dipping 30° to 60° are abundant enough to produce a zigzag surface of spalling upward and outward from the limits of an undercut area. On the other hand, ground movement might affect these figures materially. For example, block 7–1 is known to have yielded about 165% of the computed volume of ore. Available evidence suggests that the additional ore was derived largely from lateral movement of the stope walls.

Ultra-Deep Mining on the Rand

The March issue of *Optima*, the quarterly review published by the Anglo American Corporation of South Africa, contains an article by F. G. Hill on " Special Techniques for Ultra-Deep Mining." After a review of the difficulties created by pressure and heat the author goes on to say that a third problem inherent in an ultra-deep-level mine concerns rising costs, for its life may become precarious as the mine deepens and the level of costs rises close to the level of revenue earned. In laying out a mine that will probably cease working because of costs as distinct from exhaustion of ore it is essential right from the beginning to spend time and money on initial layouts that will lead to the lowest possible overhead costs.

The decision of Anglo American Corporation to

open up an ultra-deep level mine south of the West Driefontein and Blyvooruitzicht mines was bold and imaginative, and, the author points out, an example of the courage and vision for which the late Sir Ernest Oppenheimer was so well known. It was a tribute also to South African mining and mechanical engineers, for this decision could not have been taken without full confidence in their ability to surmount the particularly severe problems that would have to be faced in exploiting ore from depths below 8,000 ft. South Africa has had a wealth of experience in deep-level mining, for no fewer than eight mines on the Central Witwatersrand have reached depths greater than 8,000 ft.—namely, Durban Roodepoort Deep, Rand Leases, Consolidated Main Reef, Crown Mines, Robinson Deep, City Deep, Simmer and Jack, and finally East Rand Proprietary Mines. The nature of these special problems are such that the most important weapons for combating them are the initial planning and layout of a mine's shafts and its development and stoping patterns. The engineers responsible for spending more than £25,000,000 on this giant mining enterprise, the author says, have shown themselves fully cognisant of the pressure, heat, and cost factors confronting them, and are preparing to meet these difficulties.

Much thought has been given to future pressure problems—for example, to the sizes of shaft and boundary pillars, the positioning of footwall excavations and the sequence of pattern of stoping. The suggestion that large areas of reef be left *in situ* as vertical shaft pillars, water barriers, and stabilizing zones is indicative of the care being taken to make working conditions as safe as possible.

The question of leaving ore immediately around vertical shafts to serve as pillars, or, alternatively, of removing reef around the shafts as the first stage of stoping, is still being debated by mining engineers. If no water problems are associated with removal of the ground around the shaft it seems unquestionably the better practice to remove this ground first and thus eliminate pressure troubles for all time in the shaft and its adjoining footwall excavations. If, however, the strata surrounding the shaft are water-bearing, it is wiser to leave a pillar because settlement may allow water to flow unchecked into the shaft, but the pillar must be large, otherwise its removal will be fraught with many perils. But what is large ? A pillar of 1,000 ft. diameter may, as experience has shown, be too small for a depth of 6,000 ft. and a diameter of some 2,000 ft. would seem to be advisable for depths of 8,000 ft. or more. Provision for pillars larger than this is being made at Western Deep Levels, thus ensuring that the main vertical arteries of the mine are kept intact until the mine nears its end.

The size of the boundary pillar between Western Deep Levels and its northern neighbours is also a matter to which a great deal of thought is being given. The pillar will be at a depth of 8,000 ft. and if cut to the normal legal requirement of 60 ft. wide, would be fractured and weakened over its full length. This would cause no fears were it not that Western Deep Levels will still be working after Blyvooruitzicht and West Driefontein have ceased mining and the water building up in these latter two mines might burst through the pillar. No chances of this kind are to be taken, for the design engineers plan to leave a 1,000 ft. wide pillar along the whole northern boundary. It is believed that this will give the mine ample protection against the danger of a water inrush from the northern mines, but, as water may be encountered under very high pressure in fissures traversing the mine, provision is being made for sub-dividing the mine into compartments, each of which could be sealed off from the mine as a whole.

For the purpose of reducing pressure troubles during the development and stoping layout for the Carbon Leader Reef certain important practices are proposed. The stabilizing zones of intact reef are an example ; the object of these is to limit the span of the stoped areas and the thrust on the abutments. Reef driving will be at a minimum for any pre-existing excavation in the reef plane makes subsequent stoping less safe. The reef will be opened up from a series of inclined shafts and by drives and haulages placed at a safe distance in the footwall ; most important of all a system of concentrated longwall stoping is proposed as against a system of scattered stoping. If exploration by bore-holes from footwall drives reveals unpayable areas the stoping will be so planned that the payable faces work towards the unpayable ground. The avoidance of island, peninsula, and acute cape abutments will be inherent in stope planning and provision is being made to pack as much waste rock as possible and as soon as possible in stoped-out areas. Finally, full use will be made of the knowledge that the industry has accumulated on the factors that affect the incidence of bursts and on such ameliorative measures as de-stressing.

The shafts planned for the Carbon Leader horizon show how aware the responsible staff are of the need to provide large volumes of downcast air. It has been shown that cooling and work performance are improved by velocity, which in turn depends on volume and control of air. Other advantages of large volumes of air compared with smaller volumes are ; first, less heating of the air by the rock, and secondly, dilution of dust. Essential in the design of an ultra-deep level mine, then, is the provision of large volumes of air. The Western Deep Levels mine is meeting this requirement by

(*a*) having four 26 ft. diameter circular shafts for the top half of the mine ;

(*b*) having four 20 ft. diameter circular upcast shafts and adequate return airways feeding these shafts ;

(*c*) streamlining the supports, or having rope guides so that the maximum amount of air courses through the shafts at a minimum of cost ;

(*d*) providing large horizontal intake airways ;

(*e*) providing concrete-lined inclined shafts 4,000 ft. apart on strike, and

(*f*) removing free water from the upcast shafts so as to reduce resistance.

As far as condition of the air is concerned every effort is to be made to keep the downcast air dry—for example, by sealing off water from the intake airways, by having separate haulages for ore and for drains, and by leading intake air to the working stopes as quickly as possible by the shortest route. Controlled coursing will ensure the best quality of air.

In addition to keeping the air dry, however, plans are being made to cool the air by refrigeration plants and the use of heat exchangers. The refrigerating plants will be situated 8,000 ft. below surface and cooling power transferred to the deepest portions of the mine by means of chilled water reticulation

and cooling coils. The re-conditioning of air underground will also be practised, the degree and extent being determined by the heat conditions.

If it is assumed, says the author, that effective means will be developed to combat pressure at greater depths, it is clear that the richness of a mine will determine its depth and life since both the heat and cost factors can be overcome by providing sufficient funds from revenue. The point to be stressed, however, is that much of the money needed to deal with heat and rising costs should be made available in the early stages of a mine's layout and development, for it is the broad initial master plan that will largely determine the overhead costs with which the mine will be saddled in its later days. No reference need be made to the direct working costs that the mine will normally incur in development and in producing ore for the mill, for it will clearly be every manager's endeavour to keep these as low as possible. But he cannot readily change what his forerunner did by way of major layouts and equipment, for such changes might require large capital sums when the mine is in a poor position to meet the bill.

Therefore, the main features of the layout of a mine like Western Deep Levels—a mine whose life will in the end be fixed by depth of working and not by its present southern boundary—should be boldness and low overhead service costs. Boldness will ensure that the main arteries to the deepest levels will be adequate for men, material, air, and ore, and low overhead costs will obtain if operational research methods are applied to the design and equipment of shafts, stations, ore bins, and haulages. If the plans of the present team of engineers are implemented they will exhibit both these features—namely, boldness and low cost structure—thus aiding the mine considerably in its last days—perhaps at depths of 14,000 ft. to 15,000 ft. ?

Though working in a hot deep mine cannot be said by any means to be pleasant or congenial the accident and sickness rates, are in fact, little greater than in shallower mines, as the recorded figures from the deepest mines show. In terms of safety and health, therefore, our ultra-deep-level workers are not being exposed to unduly high risks and they are making a most significant contribution to the country's wealth. On the Central Witwatersrand millions of ounces of gold have already been won from below the 8,000-ft. horizon. Every thousand feet of depth means to South Africa tens of millions of pounds in foreign exchange; it is interesting to record that, assuming a grade of 10 dwt., the gold recovered from every extra 1,000 ft. of vertical depth achieved on a mine of the size of Western Deep Levels would mean, at the present price of gold, £225,000,000 in revenue.

How rewarding then, the author suggests, to persist in studies of pressure, heat, and cost problems and to strive to mine ever deeper and deeper, for each success will mean longer life to many mines, greater economic stability to South Africa, and a substantial contribution to our national wealth.

Ore Treatment at Wattle Gully

An account of "Wattle Gully's New Flowsheet and Mill" is given by J. T. Woodcock in an article appearing in the *Chemical Engineering and Mining Review* of Melbourne for January 15. The author says that for 25 years, from 1934 to the present, Wattle Gully Gold Mines, N.L., has been mining and milling a lode-gold ore at Chewton, near Castlemaine, Victoria. Treatment has consisted of stamp-battery crushing and amalgamation, with production by tabling and straking of a sulphide concentrate for cyanidation. The initial 10-head plant has been extended and modified at various times so that by 1958 the main plant consisted of a central crushing station from which crushed ore was distributed to two quite separate batteries—an old 30-head and a fairly new 20-head. Both plants contained amalgamation and tabling sections. There was also a central concentrate cyanidation plant. For various reasons the company decided early in 1959 to construct a new mill to use a more efficient process. In this new mill crushed ore is ground and coarse gold concentrated by a jig while fine free gold and auriferous sulphides are recovered by flotation. Jig concentrates are redressed, amalgamated, and then cyanided with the flotation concentrate. It was decided that of the existing equipment only the central crushing station should be incorporated in the new mill and process. The rated capacity of the mill is 70,000 tons per year of 50 weeks of five working days. Milling rate is 12 tons per hour. Annual throughput may be increased by working six or seven days per week or by installing additional equipment and provision was made in the mill design to do this. Construction was started in March, 1959, and during December, 1959, the mill was brought into operation.

Wattle Gully ore is essentially a free milling gold ore and mill feed has averaged 7·5 dwt./ton gold for the 609,000 tons produced to 1958. However, grade of ore milled fluctuates from 2 dwt./ton to 20 dwt./ton over relatively short periods.

The gold occurs as native gold about 950 fine. An important feature from the treatment viewpoint is that some 80% of the gold is coarser than 200 mesh and small nuggets occasionally report. This coarse gold amalgamates readily and can be recovered by direct amalgamation or by gravity methods. About 10% of the gold is associated with sulphides which constitute up to 2% of the weight of ore. The sulphides are principally arsenopyrite and pyrite, but many other sulphides occur in minor amounts and gold is often associated with galena. Gold associated with sulphides is fine in size, but most of it can be exposed by fine grinding and recovered by cyanidation. The remaining 10% of the gold is associated with gangue minerals, principally quartz, with some sandstone and perhaps 15% slate.

Most of the fine free gold and auriferous sulphides can be recovered by flotation and the concentrate cyanided without difficulty. This is the preferred process although direct cyanidation of ore can recover up to 0·2 dwt./ton more gold. Liberation of coarse gold is obtained by crushing to 16 mesh and most of the sulphides are also liberated at this size. However, for satisfactory liberation of fine gold from gangue it is necessary to grind to about

70% finer than 200 mesh. Grindability tests have shown that for a quartz ore the ore is of average hardness and about 9 kWh per ton are expected to be used in grinding.

Ore reserves are adequate to enable the cost of the new plant to be amortized.

Crushing

Run-of-mine ore is hoisted in 15-cwt. mine trucks on to the upper head-frame brace and dumped directly to a 36-in. Traylor gyratory crusher. Crusher discharge is *minus* 1½ in. and is screened on an 8 ft. by 4 ft. Cateract vibrating screen having ½ in. by 1½ in. rectangular apertures. Screen oversize passes to a 20-in. Traylor gyratory crusher, where it is reduced to a nominal *minus* ⅝ in. size and rejoins the screen undersize. This crusher station is located at the shaft while the new mill is some 400 ft. away. Crushed ore is conveyed in two stages to a circular 450-ton fine-ore storage bin at the mill. One of the conveyors involved was already in place and supplied ore to the 20-head battery, but an additional 200-ft. conveyor was needed to transfer ore to the new storage bin.

Grinding and Jig Concentration

Crushed ore from the bin is delivered by Wilunatype feeders to a short 24-in. conveyor and then transferred to a 16-in. mill feed belt. These two belts are electrically interlocked. Ore is fed *via* a chute and drum feeder to an 8 ft. by 6 ft. overflow Ruwolt ball-mill driven by a 180-h.p. motor.

Wave-type liners on Linatex backing are used and gaps between liners were packed with Semtex to eliminate pockets for gold lock-up. A light ball-load weighing 10 tons and made up of 4-in., 3-in., and 2½-in. balls was used for start-up but this was soon increased to 11 tons. Final running load will be determined from electrical input readings.

The ball-mill discharge trunnion is fitted with a chip rejection screen which discharges to a box, located in the ball-mill discharge security area. Ball-mill chips and large gold nuggets will report here.

Ball-mill discharge is pumped by a Warman pump to the top of the mill building and fed to a 16 in. by 24 in. duplex Denver jig which is covered with a security screen. Provision has been made to by-pass the jig so that grinding can continue with the jig out of circuit. This will be necessary for routine cleaning of gold and debris from the ragging and also because high-grade patches of ore could lead to sudden excessive accumulation of gold on the screen. Installation of a spare jig did not seem to be justified.

Jig hutch concentrate is collected in a concentrate receiver and tailing is fed by gravity to a Warman 16-in. cyclone. Cyclone spigot product returns to the ball-mill, while cyclone overflow at 60%–70% *minus* 200 mesh and 30%–35% solids gravitates to a conditioner. This pulp is suitable for direct flotation.

Flotation

Cyclone overflow is conditioned in a 12 ft. diameter conditioner giving a nominal retention time of 30 min. Conditioned pulp is pumped to a bank of twelve 44 in. by 44 in. Fagergren flotation cells arranged in sets of 2, 6, and 4 cells, giving a flexible rougher-scavenger circuit. Flotation feed enters cell No. 1 and flows down the series. Finished concentrate is taken off cells No. 1 and 2 and some of cells 3–8. Scavenger concentrate is taken off the remainder of the cells and returned to the conditioner.

The main emphasis will be on achieving high recovery of gold by flotation and concentrate grade will be relatively unimportant. Flotation tailings are expected to assay 0·25 dwt./ton. Concentrates assay 2 oz./ton to 5 oz./ton and will constitute some 2% of the weight of feed.

Flotation is conducted at pH 8–9 and although the natural pH is about 8 soda ash is added to the ball-mill as a conditioning agent. Promoters used are secondary butyl xanthate, Aero Promotor 208, and Aerofloat 15. Part of the reagent addition is made to the ball-mill, part to the conditioner, and part to the flotation cells. For froth control cresylic acid is used in conjunction with the Aerofloat 15.

Flotation concentrates gravitate to a Warman thickener and thickened concentrate is cyanided as described later. Thickener overflow gravitates to the circuit water tank.

Flotation tailings are pumped through a Warman cyclone to remove sand which is pumped to a 700-ton tank and used for underground fill. Cyclone overflow is pumped to a new tailing dam which is being built in an isolated valley and is estimated to provide room for 400,000 tons of tailings.

Treatment of Jig Concentrate

Jig concentrate make will be the minimum required to give a satisfactory recovery of gold too coarse to float. This concentrate make is too great for daily barrel amalgamation so that redressing of primary concentrate is necessary. This is done by storing 24 hours' production of concentrate in a receiver and retreating it daily by tabling on day shift. The table yields a gold-sulphide concentrate for amalgamation, a sulphide middling for return to the ball-mill, and a tailing for return to the ball-mill discharge pump box.

Amalgamation and retorting of amalgam are conducted by conventional methods. Gold will also be recovered from the ball chips and from the jig ragging and will be melted for barring with the retort sponge.

The amalgamation tailing is added to the flotation concentrate for cyanidation. It is therefore necessary to fine-grind during amalgamation to provide suitable cyanide feed.

Cyanidation of Flotation Concentrate

Thickened flotation concentrate is cyanided directly without further grinding as it is already sufficiently fine in size. Thickener underflow is maintained at a high density for cyanidation in order to reduce filter duty and minimize discard of barren solution.

Cyanidation procedure is to fill alternately with thick pulp Agitators Nos. 1 and 2 and add the necessary quantities of lime, Aero brand cyanide, and litharge or lead nitrate. Each batch of pulp is agitated for 24 hours and then filtered on a 5½ ft. by 4 ft. Oliver filter using barren solution-wash sprays. Filter cake is repulped with barren solution and then refiltered several times on the same filter using Nos. 3 and 4 Agitators as surge tanks. The final filter cake is pulped with fresh water and barren solution and pumped to the residue dam. Solution circuit balance is maintained by using the same volume of barren solution for repulping as that of water entering the cyanidation circuit with the thickener underflow.

Filtrate solution from each stage of filtration is sent to a pregnant solution storage tank. Pregnant solution is clarified with a leaf clarifier and de-aerated. Zinc dust is then added and the precipitate filtered off in a filter-press. Precipitate is roasted, fluxed, and smelted by conventional methods. Barren solution is sent to a storage tank and pumped to a steady-head tank for use in the circuit.

Provision has been made for duplication of certain equipment should future expansion be decided upon and there is room for extension or installation of certain other equipment. Thus sufficient room has been provided for the installation of another ball-mill or a rod-mill on the other side of the feed conveyor parallel to the existing ball-mill. Space has been left for duplication of the flotation cells facing the present bank.

It is possible that secondary gravity concentration on the cyclone overflow will be found necessary before flotation. This could be conducted by a Johnson concentrator and there is space on the mezzanine floor for this.

Gold Room

In treating a gold ore containing such very coarse gold extensive security precautions are needed and great care will be taken in this regard. As mentioned before, ball-mill discharge and the jig are suitably enclosed and shift operators will not be allowed access to pulp in the ball-mill-jig-cyclone circuit. Pockets where gold can accumulate have been eliminated where possible and the cyclone and drum feeder are much better in this respect than a mechanical classifier and scoop feeder. Nevertheless maintenance on the circuit will have to be done under adequate supervision. Rubber linings have been used extensively on wearing surfaces.

A properly enclosed gold room on the ground floor and on the mezzanine floor has been provided in the mill building itself, where all products containing coarse gold, amalgam, and gold precipitate are handled. The gold room is in full view of the rest of the plant and security generally is better in the new plant than in the old.

The Muriel Mine Southern Rhodesia

In the Southern Rhodesian *Chamber of Mines Journal* for February there is a brief account of the Muriel mine, an active gold producer This property is situated in the Banket district at an altitude of about 4,200 ft above sea-level The town of Banket lies about 23 miles away by road, the mine having built a short connecting road to link with the main chrome haulage road along the western side of the Great Dyke which connects to the north with the main road to Salisbury through Mtoroshanga and Concession and to the south with the main road from Salisbury to Northern Rhodesia. In addition the mine has developed its own all-weather air strip which is suitable for light planes.

The ore deposits occur near the eastern end of a narrow ½-mile to ¾-mile wide east–west belt of Pre-Cambrian rocks of Bulawayan and Shamvaian age. Granite lies to the north and south of this belt and the Great Dyke cuts off the eastern end of it about 2½ miles east of the mine. To the west the belt gradually widens and joins the Banket–Sinoia Sipolilo gold belt. At the mine the southern part of the belt is composed of rocks of Bulawayan age, mainly hornblende schists with thin, interbedded, metamorphosed sediments. Overlying this series on the north side are metamorphosed sediments of Shamvaian age. These formations have a general east–west strike and a steep northerly dip.

The veins of the mine are developed chiefly in the Bulawayan hornblende schists, the better ore-bodies favouring the contacts of the hornblende schists with the interbedded sediments. The fissures are essentially narrow shears mineralized with pyrrhotite and chalcopyrite within which are developed thin lenses of white to glassy quartz carrying the same sulphides and most of the gold. The shears conform to two general strikes of 15° south of west and 20° north of west. Their dips are very steep to the north with local steep southerly dips developing.

The quartz lenses in the shears predominantly occur *en echelon*, stepping to the south going west and pitch westward at an angle of around 60° from the horizontal. The pitch of the lenses conforms closely to the lineation and the lenses are persistent in the direction of pitch.

Numerous post-mineralization cross-faults occur in the mine. Their horizontal displacements are generally small, their vertical displacements difficult to determine. One vertical north–south fault, associated with a 40-ft. thick dolerite dyke, may have a large displacement. The original discovery ore-shoot of the Muriel pitched into this fault and terminated against it.

Flotation tests of the ore showed that a copper-gold concentrate, leaving a reasonable gold content in the residues, could be produced with a saleable copper content. No local market existed for a copper-gold concentrate and after investigating various overseas markets the best sale for the concentrates was found in the United States. Between 175 tons and 200 tons of concentrates giving over 20% copper are being shipped monthly from the mine at present.

From 1934 the mine continued to run as a small producer milling about 1,000 tons per month until August, 1953. For some years previous to 1953 ore reserves had been steadily increasing and a new plant had been planned. This plant went into production on a planned basis of 2,000 tons per month in September, 1953. The plant proved capable of milling much more than was planned and with slight modifications is now milling around 4,500 tons per month.

The total production of the Muriel mine from the start of milling in 1934 to the end of June, 1959, is recorded as 251,295 oz. of gold and over 5,000 tons of copper from 507,249 tons milled, an average recovery of 9·9 dwt. of gold.

Trade Paragraphs

Lockers (Engineers), Ltd., of Warrington, draw attention to the fact that in the note published on page 147 of the March issue of the MAGAZINE regarding their exhibit at the Mineral Processing Exhibition the capacity figures for their range of feeders was given incorrectly. This should have read " capacities from a few pounds up to 2,000 tons per hour." The careless slip is much regretted.

Rocol, Ltd., of Rocol House, Swillington, near Leeds, have produced an illustrated booklet entitled Rocol—First in Molybdenum Disulphide Lubrication, which shows how molybdenum disulphide is purified and prepared, gives the results of some of the tests on various types of equipment, and describes its salient properties.

English Electric Co., Ltd., of Stafford, recently announced a new range of totally enclosed fan-cooled motors, called type " D," which have outputs up to 100% greater than existing motors of the same size, type " B." The greater outputs have been achieved by allowing for a temperature rise of 65° C. above 40° C. instead of the existing 55° C. This results from the use of class " E " insulation instead of class " A." These new motors are designed for wide industrial application, particularly where there is dust and dirt in the atmosphere—such as, pumps and compressors in the chemical, oil, and mining industries.

Malcolm Campbell (Plastics), Ltd., of 5, Great James Street, London, W.C. 1, have introduced to their Texolex safety helmets a new reinforcement of the low crown shell. The manufacturers offer various types of cradles to suit the conditions in which the helmets are used. They recommend the fixed sizes of basil leather head-cradle with a patented retainer piece attached. This retainer fits closely round the back of the neck and takes the place of a chinstrap and also avoids tilting if the peak is subjected to impact. The shells of Texolex safety helmets are made from high-pressure laminates of Lancashire cotton and resin and will withstand immense impacts. Specimen helmets with or without lamp brackets and further information may be obtained from the company.

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, have developed a new wet pick for use where suppression of dust by water spray is required. In this pick water is fed to a swirl spray fitting, sited near the nose, resulting in the formation of a dense mist round the pick steel. The high concentration of finely-divided water particles so formed enables a very high degree of wetting of the dust raised by the pick steel to be achieved while at the same time enabling the rock being worked to be kept thoroughly wet. Air and water channels are independent and of particular note is the fact that the model is water controlled and cannot be operated as a dry machine due to the design of the throttle, which requires water at a pressure of 20 lb./sq. in. minimum pressure before the air control becomes effective.

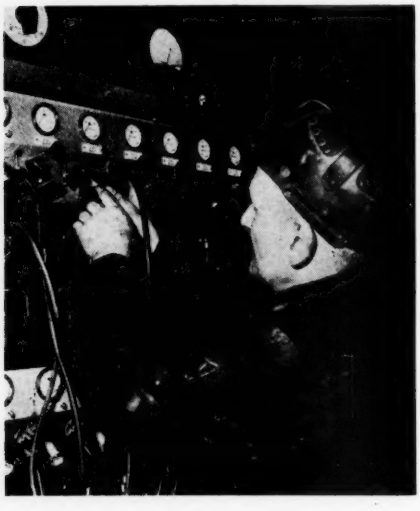
General Electric Co., Ltd., of Erith, Kent, have received a further contract from the United Kingdom Atomic Energy Authority, Risley, for electric furnaces for use in the production of plutonium metal. This latest order covers reduction and fluorination furnaces. The fluorination furnace is rated at 10 kW and is of the horizontal front-loading type, complete with muffles, the inner surface of the muffles and doors being lined wth platinum. A forced cooling system is incorporated to enable the charge to be cooled within a stipulated time. The furnace for the reduction process is rated at 50 kW. It is of a bell-type design and has a forced cooling system similar to the fluorination furnace. Electrical equipment being supplied includes regulating transformers, temperature control gear, and the necessary switch-gear.

Allen West and Co. Ltd., of Brighton, announce that Sir Henry Self recently opened their new electrical proving station and research laboratories and have issued a well-illustrated booklet which describes the various departments and some of the equipment used. This points out that virtually all forms of switchgear and control gear have to make and break electric loads varying in severity according to the service they have to perform. The behaviour of the contact and the control of the arc under working conditions are therefore of considerable importance. The power testing station which forms a part of the laboratories is equipped to carry out research into arc control on both a.c. and d.c. voltages from a few volts to 11kV in a.c. and 1·5 kV in d.c. Similarly contactor and starter load-breaking tests are made up to 8·7 MVA or for small circuit breakers up to 25 MVA.

British Geon, Ltd., of Devonshire House, Piccadilly, London, W.1, announce that work will shortly begin on an extension to their polyvinyl chloride plant at Barry, South Wales. British Geon is jointly owned by The Distillers Co., Ltd., and the B.F. Goodrich Chemical Co. of America. In an illustrated booklet entitled The Geon Story they give examples to show that PVC is processed into a number of characteristic secondary forms—plastics sheeting ; leathercloth and coated fabrics ; piping, sheet, and cellular products in both flexible and rigid forms. These secondary vinyl materials are fabricated into a variety of finished products and also employed in the construction of chemical plant, for water piping, and thermal insulation. Other typical applications include non-flammable conveyor belting mine ventilation ducting, and protective wear such as miners' knee pads.

Holman Bros., Ltd., of Camborne, recently announced that they have enlarged and re-equipped their Durion hard chrome deposition plant. This Climax plant works in close co-operation with **Durion, Ltd.,** of Bracknell, Berks. In some explanatory notes the company point out that a significant development is the increasing number of components previously made from stainless steel now being machined from mild steel and subsequently hard-chromed by the process. This involves the electro-deposition of chrome, after varying and exacting pre-treatments, direct on to ferrous or non-ferrous metals. The extent to which a component is treated can be accurately controlled and any portion of the component can be isolated, the areas which do not require plating being protected by means of a wax coating. The thickness of deposition can be varied from 0·00005 in. to more than 0·10 in. and in exceptional cases, particularly in the salvage of stainless-steel parts, 0·20 in. has been deposited. An interesting example quoted is in the wire mesh of a screen which has been rendered both hard wearing and corrosion resistant.

Oldham and Son, Ltd., of Denton, Manchester, state that their cap lamp, in widespread use throughout the mining industry, is helping to solve one of the manager's most constant problems—the deployment of underground workers. In Abergorki Colliery, Mountain Ash, has been installed what is believed to be the answer to this daily problem, a simple automatic electrical system devised by the N.C.B.'s South Western Division Deputy Chairman, Mr. A. Walsh. The installation was developed, in



conjunction with Oldham's and **A. T. and E. (Wigan), Ltd.** The system centres around an indicator board at the pithead, on which the name of every underground worker is displayed. Against each name, which is printed together with the man's qualifications on a movable card, is a drop-flap indicator and a light. The indicator is connected to a micro-switch on his locker-door—hence giving ready information that he has come in for his shift—and another micro-switch is connected to the charging point for his cap lamp on the Oldham charging frame. The removal of the cap lamp switches on the light next to the miner's name and thereafter not only records the fact that he is at work but his exact location underground.

Metal Industries Group, of Brook House, Park Lane, London, W. 1, announce that contracts from Northern Rhodesia and India have been awarded to two companies in the Group. Lancashire Dynamo, through its Central African company, has received an order for six 1,500-h.p. 11-kV, water-cooled synchronous motors for driving main drainage pumps at Bancroft Mine in Northern Rhodesia. This is the first time that motors of this voltage have been used on any of the mines of the Anglo American Corporation on the copper belt. Previously all motors have been wound either for 3·3 or 6·6 kV, but since the mains supply to the mine is at 11 kV this meant that they either had to transform to the lower voltage above ground and then have heavier cables going underground or take the 11 kV underground and have the transformers in the mine, which necessitated the excavation of underground transformer chambers. By utilizing 11 kV motors the cost of transformers is eliminated completely, as is the cost of the L.T. switchgear ; smaller cables are utilized throughout. The second order, secured by J. G. Statter and Co., is for an 11 kV metal-clad 350 MVA rupturing capacity switchboard for the Durgapur steelworks. This follows a similar order placed earlier in the year.

Dunford and Elliott Process Engineering, Ltd., of Linford Street, London, S.W. 8, state that a rotary discharge valve designed to provide continuous and free discharge of fine powders from hoppers or bins has been produced in a very compact form. It consists of a horizontal body with 8-in. square inlet and outlet flanges between which a 9-in. diameter four-bladed rotor revolves on a longitudinal axis. The rotor is shrouded and a positive seal is obtained between it and the housing by means of renewable hard felt seals recessed into the main body casting. Complete gas and dust tightness is ensured by the stainless-steel or neoprene rubber adjustable sealing and wearing strips which are fitted to the tips of the rotor blades. The space saving feature of its design is the mounting of the reduction gearbox to form one end cover of the valve body, which eliminates the use of couplings or chain drives. The rotor is carried on the drive shaft of the gear unit, the drive being transmitted through a shear pin to prevent damage to the gearbox or to the motor in the event of overloading or jamming of the rotor. The unit is powered by a ¼-b.h.p. totally-enclosed fan-cooled, continuously-rated squirrel-cage motor which, driving through a triple-reduction gearbox, provides a rotor speed of 12 r.p.m. The rotary discharge valve is manufactured in cast iron or stainless steel and is available in two sizes—as a single type unit having a capacity of 100 cu. ft. per hour or as a duplex type unit with double this capacity.

E. J. Longyear Co., of 76, South 8th Street, Minneapolis, Minnesota, issue some notes on wire line core barrels of a new design they have introduced which recover cores up to 25% larger in diameter. The new " Series 10 " increase core size to $1\frac{13}{16}$-in., $1\frac{5}{16}$-in. and $1\frac{49}{64}$-in. for AX, BX and NX barrels respectively, but drill the same size holes as the old AX, BX, and NX designs. The narrower kerfs of bits which may be used reduce the carat weight of diamonds by 10%–20% and also help to increase penetration speed and bit life. The wire line drill rods have not been changed. Several million feet have been drilled with this wire line equipment since it was introduced eight years ago. The principle has been applied successfully in many different formations and has accounted for great advances in core recovery, footage per shift, and diamond bit life. The makers state that with wire line the driller does not have to " pull " the entire string of drill rods to reach core in the core barrel at the bottom. Instead he lowers an overshot latching device through the rods on the end of a cable. The overshot releases the special inner tube of the wire line core barrel so that it can be hoisted to the surface while the drill rods, bit, and core barrel outer tube remain in the hole. While core is being removed from the inner tube a second one is dropped or lowered into position and drilling resumed.

Humphreys and Glasgow, Ltd., of 22, Carlisle Place, London, S.W. 1, have made available some information regarding their mine car retarders, one of which is shown in the illustration. The range

Mine Car Retarder

available is such that a selection may be made that will limit the force on the axles below that which will cause derailment or damage. No springs or air-operated devices are incorporated to effect a return stroke, there being only two moving parts. The hydraulically-applied retarding force becomes effective after making contact with the axle and is relieved before disengagement. Two controls are provided; one sets the limit of the force which can be applied to the axle at any one time and the other the outgoing speed of the cars. As each axle passes through the retarder the first moving component is turned about 60°, during which the car advances under controlled retardation and up to a set limit. The same axle passes to the second moving component, which is geared to the first, and a further operation takes place driving the car in the reverse direction and bringing the first component to its original position ready to receive the second axle of the car. Thus four distinct retardations are applied to each car as it advances about 4 ft.; cars in pairs receive eight retardations in 12 ft. Units which are retractable by remote-controlled cylinders or mechanical means are supplied where it is necessary for locomotives to pass.

Richard Sutcliffe, Ltd., of Horbury, Wakefield, announce the introduction of a new type of water infusion pump and water infusion gun. The pump is arranged for variable output and consists of an oil hydraulic circuit which drives two reciprocating rams which are in turn directly coupled to the two rams of the water pump. The oil is supplied from a variable-delivery pump which allows the oil circuit to select automatically the pressure and quantity of water to which it is best suited. The output of the water pump is 8 gallons at 3,000 lb. per sq. in. and is infinitely variable down to 22 gallons at 1,100 lb. per sq. in., the pressure and volume varying inversely. The control of the pump can be adjusted so that an output of 5 gallons at 1,500 lb. per sq. in. can be obtained to supply water for a conveyor ramming system at the same time. Under these conditions, at a small extra cost, the oil circuit can be used to drive say a stable hole conveyor or a hydraulic drill. The variable-delivery oil pump is driven from a 30-h.p. fan-cooled, flameproof electric motor. Mounted above the electric motor and pump is a mild-steel tank with two compartments in which are stored the water and the hydraulic oil. A thermostat is fitted to the tank. The whole of the equipment is mounted on a mild-steel fabricated baseplate. The mounting brackets for the wheels are so arranged that they can be readily altered to suit any gauge. The new infusion gun has been designed to work with this equipment and has, it is claimed, already proved itself superior to other types.

Adequate Weighers, Ltd., of Bridge Road, Sutton, Surrey, announce the intermittent gross weigher designed to provide a fully automatic instrument which will record the weight of material carried over a system of ariel ropeway conveyors. The machine, which does not require any attendant operator or halt the flow of containers, comprises a lever system with a pendulum resistant, a pendulum clamping device, and the company's integrator incorporating a special gear mechanism to isolate the totalizer when required.

The sequence of operation is generally as follows:—A skip carriage moves on to the weigh rail, which is suspended from two tubular levers. The load applied to the weigh rail is transmitted by the two power arms to a further single lever projecting at right angles. The applied load on this lever is in turn transmitted to a connecting rod which transfers the load to a further lever system incorporated with the recording mechanism, which is normally situated at ground level. The resultant force of this final lever system is applied to the pendulum resistant. All pivot points take the form of knife edges and

bearings and lever designs will vary as necessary to suit requirements. The pendulum carries a fork which controls the lateral movement of the steel ball drive in the integrating mechanism. As soon as a skip is fully on the weigh rail it trips a switch which first releases the clamping mechanism on the pendulum and allows the pendulum to adjust itself to the weight of the skip and then starts a time relay mechanism. Before the skip moves off the weigh rail the time relay mechanism operates the clamping mechanism to hold the pendulum at the position indicating the weight of the skip. A fraction of a second later it starts the recording cycle. The special gear mechanism engages the totaliser with the continually running integrating mechanism for the precise period of time required to record the weight of the skip. While the gear mechanism disengages the totalizer as soon as the weight is registered the pendulum resistant remains held firm at the position indicated by the last weight until the next skip releases the mechanism.

Mechanical Handling Exhibition

Held every two years the Mechanical Handling Exhibition will take place at Earls Court, London, on May 3 to May 13. Among the products in the wide range of exhibits planned are conveyors and elevators, hoists and pulley blocks, pneumatic handling plants, coal and ore handling equipment—including screens and tipplers, trucks, aerial ropeways and cableways, and cranes—and a variety of earth-moving equipment. A number of companies known as manufacturers of mining machinery will be among those represented.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

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26,131 of 1956 (827,205). W. Wenzel. Electric reducing process and furnace for carrying out the process.

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Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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